

Estimating the In-Country Distribution Costs of Malaria Commodities in Benin and Kenya

April 2014



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William Davidson Institute
AT THE UNIVERSITY OF MICHIGAN

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antimalarial, distribution from central to peripheral stores, cost, cost analysis, Kenya, Benin, public sector

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CONTENTS

Acronyms and Abbreviations	v
Acknowledgments.....	vi
Executive Summary	vii
Background	1
Methodology	2
Sample Site Selection	2
Survey Guides	3
Data Collection	4
Assumptions and Depreciation Rates	4
Benin	6
Supply Chain Structure: Procurement and Distribution of ACTs and RDTs	6
Costing Methodology.....	6
Data Analysis	7
Kenya	21
Supply Chain Structure: Procurement and Distribution of ACTs and RDTs	21
Costing Methodology.....	22
Data Analysis	23
Conclusions.....	34
Recommendations.....	35
Next Steps for Development of an Extrapolative Model.....	35
Annex A. Benin Survey Sites	37
Annex B. Benin Depot and Health Facility Specifications.....	38
Annex C. Benin Annual Utility Cost of Each Depot and Health Facility to Store Commodities	39
Annex D. Benin Annual Labor Cost Calculation of Each Depot and Health Facility to Store and Distribute Commodities	40
Annex E. Benin Annual Security Cost of Each Depot and Health Facility to Store Commodities	41
Annex F. Benin Annual Transportation Cost of Each Depot and Health Facility to Retrieve Commodities	42
Annex G. Benin Annual IT Cost at Each Depot and Health Facility to Store Commodities	43
Annex H. Benin Annual Equipment Cost of Each Depot and Health Facility to Store Commodities	44
Annex I. Benin Annual Warehouse Cost of Each Depot and Health Facility to Store Commodities	45
Annex J. Kenya Sample Sites	46

Annex K. Kenya Hospital and PHC Specifications.....	47
Annex L. Kenya Annual Utility Cost of Each Health Facility to Store Commodities	48
Annex M. Kenya Annual Labor Cost Calculation of Each Health Facility to Store and Distribute Commodities	49
Annex N. Kenya Annual Security Cost of Each Health Facility to Store Commodities.....	50
Annex O. Kenya Annual IT Cost of Each Health Facility to Store Commodities	51
Annex P. Kenya Annual Equipment Cost of Each Health Facility to Store Commodities	52
Annex Q. Annual Warehouse Cost of Each Health Facility to Store Commodities.....	53

ACRONYMS AND ABBREVIATIONS

A/C	air conditioning
ACTs	artemisinin-based combination therapies
AL	artemether-lumefantrine
ARM3	Accelerating the Reduction of Malaria Morbidity and Mortality
CMS	Central Medical Store
CRS	Catholic Relief Services
Global Fund	Global Fund to Fight AIDS, Tuberculosis and Malaria
GPS	global positioning system
IT	information technology
LLINs	long-lasting insecticide-treated nets
LPI	logistics performance index [World Bank]
m ³	cubic meter
MSH	Management Sciences for Health
PHC	primary health center
PMI	United States President's Malaria Initiative
PSI	Population Services International
RDTs	rapid diagnostic tests
SIAPS	Systems for Improved Access to Pharmaceuticals and Services
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
USD	United States dollar
WDI	William Davidson Institute

Benin

CAME	<i>La Centrale d'Achat des Médicaments Essentiels et Consommables Médicaux</i>
CFA	<i>Communauté Financière d'Afrique</i>
CHNU	<i>Centres d'Hôpital National d'Université</i>
CS	<i>Centre de Santé</i>
DPM	<i>Direction des Pharmacies et Médicaments</i>
DRZ	<i>Dépôt Répartiteur de Zone</i>
HZ	<i>Hôpital de Zone</i>
LNCQ	<i>Laboratoire National de Contrôle de Qualité</i>
PNLP	<i>Programme National de Lutte contre le Paludisme</i>
SG&A	selling (distributing), general, and administrative expenses

Kenya

CDF	Constituency Development Fund
CHW	community health worker
DoMC	Department of Malaria Control
HCSM	Health Commodities and Services Management
KEMSA	Kenya Medical Supplies Agency
KSh	Kenyan shilling
NQCL	National Quality Control Laboratory
PPB	Pharmacy and Poisons Board

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In Benin, we received information and time from *Programme National de Lutte contre le Paludisme* (PNLP), *Direction des Pharmacies et Medicaments* (DPM), *Laboratoire National de Contrôle de Qualité* (LNCQ), as well as the zonal depots, hospitals, and clinics that participated in this study. *La Centrale d'Achat des Médicaments Essentiels et Consommables Médicaux* (CAME) provided data collectors, information, and continued assistance over the course of the research. Management Sciences for Health (MSH)/Accelerating the Reduction of Malaria Morbidity and Mortality (ARM3) collaborated in all aspects of the field research trip.

In Kenya, we received information and time from the Department of Malaria Control, the Pharmacy and Poisons Board, the National Quality Control Laboratory as well as the health facilities that participated in the study. The Kenya Medical Supplies Agency provided data collectors, information, and continued assistance over the course of the research. MSH/Health Commodities and Services Management (HCSM) collaborated in all aspects of the field research trip.

EXECUTIVE SUMMARY

This report estimates the cost of the Kenyan and Beninese distribution networks for artemisinin-based combination therapies (ACTs) and rapid diagnostic tests (RDTs) in the public sector. Based on this work, we created an extrapolative model to allow donors and country budget planners to quickly and effectively estimate distribution costs for country roadmaps. This model is presented in a separate document.

This report achieved four objectives: (1) allow accurate costing for the delivery of malaria commodities to the end user, (2) allow accurate planning and budgeting, (3) provide realistic estimates of distribution costs for inclusion in roadmaps and proposals, and (4) inform policy discussion by improving the accuracy of costing for ACT and RDT supply chains.

The sample was purposive and small, and had some clear results by virtue of magnitude across study sites, despite the different distribution networks in both countries.

- Labor drove the costs at all tiers of the various functions,. When labor is considered in total costs, transportation results in a smaller cost to overall distribution than would have been otherwise expected.
- The primary health clinics (PHCs) represented the most costly tier. Although annual operating costs at individual PHCs is low, the volume distributed is also low. Because of this low volume, PHC costs superseded those at central and peripheral stores when measuring cost per treatment course or diagnostic test.
- Distribution costs tied to product value were highly variable. Distribution costs estimated as a percentage of acquisition costs are often inaccurate. Given that most costs would be associated with volume, such as space occupied and labor required, the only exception is the cost of insurance. The method of estimating distribution costs for budgets and proposals as a fixed percentage of product value is inaccurate without qualifiers suggesting the value of the product when the estimate was made.

Based on these findings we conclude that product volumes should be considered when costing distribution rather than value, countries should avoid using percentages of total acquisition costs to estimate the cost of product distribution, and planners and policy makers can use the information on cost drivers to conduct a more detailed analysis to determine how to increase efficiency. Given that countries should use accurate distribution cost data when budgeting for malaria interventions and that costing studies are expensive and time-intensive, a model to estimate these costs with minimal effort would be embraced by stakeholders.

Distribution costs as a percent of acquisition costs are highly volatile. There is a need for a tool that creates a more representative estimate of these distribution cost percentages in country budget roadmaps.

This work moved costing closer toward transparency and accuracy, but is still far from creating a financially transparent supply chain. As this work is only a glimpse of Kenya and Benin, a more complete picture needs routine data collection. With sufficient time-lapsed data points, statistical conclusions can be made. In addition to greater cost transparency, this could lead to a richer understanding of operational needs, such as in labor. Additionally, to make insights on supply chain effectiveness, such as whether the costs reported are being used in an appropriate way, this report should be coupled with reports on product availability, quality, and price.

BACKGROUND

The World Malaria Report (2013) estimated that 207 million malaria cases and 627,000 malaria deaths occurred in 2012, with 90% in sub-Saharan Africa.¹ The uninterrupted availability of safe and effective commodities for the treatment and prevention of malaria at the various points of service delivery is fundamental to malaria control. Adequate allocation of budgets for indirect in-country distribution costs of malaria commodities is needed to appropriately plan for scaled-up implementation. Countries and donors need specific data for budget allocation especially for activities required for in-country distribution of products once they are procured. In most endemic countries, malaria commodities are financed by external donors such as the Global Fund to Fight AIDS, Tuberculosis and Malaria (Global Fund); the US President's Malaria Initiative (PMI); the World Bank; UNITAID; and other initiatives. Under-budgeting for distribution costs and related activities can lead to commodities expiring at the Central Medical Store (CMS) or district stores before they can reach the health facilities—the final point of patient access.

The objective of this exercise was to estimate the distribution costs of artemisinin-based combination therapies (ACTs) and rapid diagnostic tests (RDTs) from the central to the peripheral levels of the public sector health system. Data were also collected to estimate the costs of distribution to community health workers (CHWs) in areas implementing community case management of malaria; however, costs of distribution in the private sector were not included in the scope of this study. The data will help countries adequately budget for public sector distribution in their country roadmaps and requests to donors. Specifically, the study estimated the precise costs associated with the following functions: procurement, product quality control, storage and inventory management, and transport.

Project Scope

- This project was intended to provide countries and donors with more accurate information on costs of distribution given the current analysis of unfounded distribution cost percentages and resource constraints in leading an extensive costing study.
- This project does not respond to what distribution should cost, but rather what it does cost.
- Given this, it is not recommended that the study findings be used to make conclusions on optimal networks or opportunities to reduce costs.

The specific objectives were to—

- Allow accurate costing for the delivery of malaria commodities to the end user
- Allow accurate planning and budgeting
- Provide realistic estimates of distribution costs for inclusion in roadmaps and proposals
- Inform policy discussions in deciding how to improve the accuracy of costing for ACT and RDT supply chains in low- and middle-income countries

¹ World Health Organization. 2013. *World Malaria Report*. Geneva: WHO.

This study was carried out by US Agency for International Development-funded Systems for Improved Access to Pharmaceuticals (SIAPS) Program, implemented by Management Sciences for Health (MSH), in partnership with the William Davidson Institute (WDI) at the University of Michigan. Two countries were selected for the fieldwork: Benin and Kenya. The criteria for selection were as follows:

- Anglophone vs. Francophone—because of different supply chain design
- East versus West Africa
- World Bank logistics performance index (LPI), which gives a composite estimate of road network maturity and may suggest an impact on transport costs²
 - Benin has an LPI of 2.85, places 83 out of 155 countries surveyed in infrastructure, and is the highest ranked low-income country
 - Kenya has an LPI of 2.43 and ranks 122 out of 155 countries
- SIAPS country presence for ease of data collection and follow-up

The costs from the two countries were used to develop an extrapolative model to estimate the distribution costs in other countries based on available data, assumptions, and proxies.

Methodology

A combination of quantitative and qualitative methods was used. Document review and semi-structured interviews were carried out at the central, intermediate, and facility storage levels. Sources for quantitative information were financial reports, CMS databases, logistics management information systems, logistics reports, distribution and health facility records, transport schedules, expenditure reports, and audit reports when available. As much as possible, data on actual expenditures rather than budgeted amounts were used, and verbal information was triangulated with supporting documentation. When this verification was not possible, the costs presented were those as outlined by interviewees; the costs they cited may refer to what was supposed to be done as opposed to what was actually done and were marked as such throughout the text. Potential inputs that contribute to the cost were identified. It should be noted that labor costs were calculated on the basis of self-reported hours.

Sample Site Selection

The study used GPS data on the location of health facilities, when available, to select a study sample. GPS data were limited to Ministry of Health facilities (i.e., district hospitals, sub-district hospitals, primary health centers, and dispensaries). Study regions were chosen based on geographic variety and malaria endemicity. Study sample sites were purposely selected to reflect

² World Bank. 2012. *World Bank Logistics Performance Index*. Washington, DC: World Bank.

sites at each tier in the distribution system in rural, semirural, and urban locations, capturing the most and least accessible health facilities. The findings are therefore not necessarily statistically representative of the entire country, but rather used key variables to isolate the elements most relevant for this costing exercise.

Survey Guides

Survey guides were developed to guide data collection on activities and their associated costs. The survey guides covered the structure and cost of procurement, quality control, storage, and transport activities. The survey guides were tailored for central, regional, and terminal warehousing or storage points including the health facility level—and for programmatic leads of the community case management of malaria (i.e., CHW) program. A preassessment survey was conducted to provide a comprehensive understanding of the context, structure, and organization of the public sector antimalarial supply chain. This survey helped refine the list of activities carried out at each stage and associated cost inputs.

The field survey guides were designed to collect data from key stakeholders on (1) activities relevant to each storage facility, (2) resources needed for each input variable activity, and (3) resources allocated specifically to ACT, RDTs, and long-lasting insecticide-treated nets (LLINs). Descriptions of each survey type are in table 1.

Table 1. Survey Guide Descriptions

Survey	Description
Pre-assessment	The survey was sent to the MSH country office before the start of field data collection. It included questions on the structure and organization of the public sector antimalarial supply chain to establish a baseline of current operating activities.
Procurement	The survey guide covered six topics in procurement activities: forecasting, procurement planning, the tender management and bidding process, order development, terms of contracting, and associated labor costs.
Product quality control	The survey guide covered three topics in product quality control activities: preshipment inspection, product quality surveillance activities throughout the distribution system, and associated labor costs.
Distribution	The survey guide covered four topics in distribution: location information, transport and vehicle costs, storage facility costs, and delivery schedules—tailored to the activities most relevant to each tier of the distribution and warehousing system. These activities included the costs of utilities, associated labor, and other services.

Data collectors had a one-day training session on the use of the computer tablet and survey guides before the fieldwork.

Data Collection

An open data kit, the CommCare HQ[®] platform developed by Dimagi, was used to develop and administer the electronic survey guides. CommCare HQ is a data collection platform that uses a free open-source software application to create survey guides and aggregate data collected. A team completed each electronic survey questionnaire in-country using the CommCare HQ platform. One team member handled the tablet device while the other took down additional notes as well as obtained documentation from logistics reports, transport schedules, expenditure reports, and audit reports, when available, from each interview site. Field data collection was carried out between September and December 2013.

Assumptions and Depreciation Rates

This study is intended to capture the costs to disburse ACTs and RDTs in the public sector in Benin and Kenya, through a CMS to clinics and hospitals. Although a CMS may distribute to nongovernmental and private institutions, this client base is often small. Therefore, all operating costs are applied to the public sector. The study attempts to capture the *actual* cost of distribution given the current state of distribution complete with its inefficiencies including stock-outs and nonadherence to standard operating procedures and not the optimal distribution scenario. Furthermore, typical utility and salary costs are assumed to be equivalent to the self-reported data collected during interviews. Data gathered consisted of cost figures both budgeted and spent. If a distinction was possible, the value of what was actually spent was used in place of what was budgeted. The analysis includes values from both types of cost figures, however.

In the case of Kenya, volumes in cubic meters of the products stocked by KEMSA were obtained from KEMSA. This information was not available in Benin, so the data were extrapolated from Kenya or standard unit volumes were used from data available from the USAID | DELIVER project and supply chain management systems. See table 2 for other assumptions used. See table 3 for depreciation figures used.

Table 2. Other Assumptions

Item	Value
Exchange rate—Kenya shillings (KSh) to United States dollars (USD), 2013 average per Oanda.com	84.76
Exchange rate—Benin <i>Communauté Financière d'Afrique</i> (CFA) to USD, 2013 average per Oanda.com	494.11
Employee retention	10 years
Default year for interview answers of facilities built >10 years ago	2000
Default year for interview answers of facilities built >20 years ago	1990
Default year for interview answers of facilities built >40 years ago	1970
If construction year is not known by interviewee	Facility considered > 30 years old
One work day	8 hours
One work week	5 days
One work month	20 days
One work year	50 weeks
Percentage of hospital utilities allocated to stock	10%
Percentage of health center utilities allocated to stock	50%
Percentage of depot utilities allocated to stock	100%
Percentage of hospital security allocated to stock	10%
Percentage of health center and depots allocated to security	50%
Volume (m ³) proportional cost allocation	Storage and transport
Volume (quantity) proportional cost allocation	Procurement tender management and product quality control
Value proportional cost allocation	Insurance

Table 3. Depreciation Figures Used in This Report

Item	Depreciation Rate ^a
Warehouse (CMS)	20 years
Asset (CMS)	5 years
Shelf (CMS)	20 years
Information technology (health center)	2 years
Shelves, wheelbarrows, fans, pallets, A/C, ladders	5 years
Hospital depreciation allocated to stock	10%
Health center and dispensary depreciation allocated to stock	50%
Total maintenance budget allocated stock	10%
Vehicles	5 years
Health facility stores	30 years

^aStraight-line depreciation applied

BENIN

Supply Chain Structure: Procurement and Distribution of ACTs and RDTs

Procurement of ACTs, RDTs, and LLINs for the public sector in Benin is carried out at the central level and coordinated by the PNLP. The PNLP is responsible for the quantification, technical specification, and final authorization for distribution. These commodities are financed by the Global Fund and PMI and are procured using international procurement agents. The CMS in Benin—CAME—is charged with the warehousing and distribution of health products to the *Centres d'Hôpital National d'Université* (CHNU), departmental hospitals, and distribution depots corresponding to each of the 34 health zones. Each health zone has at least one distribution depot which stocks inventory for the corresponding zonal hospital and multiple community health centers. CAME has three primary locations. Its headquarters are in Cotonou, where it receives the initial shipments of stock and distributes to surrounding areas. The distribution centers in Natitingou and Parakou forecast demand for their respective regions and distribute to the departmental hospitals and distribution centers in those regions. The national and departmental hospitals, CHNU and CHS, supply themselves directly from CAME Cotonou. These sites are reference hospitals and use few ACTs and RDTs, because they primarily treat severe cases of malaria.

CAME stocks approximately USD 12,143,045 (6,000,000,000 CFA) worth of products in addition to those products distributed by six health programs: PNLP, *Programme National de Lutte contre le Sida*, *L'Organisation du Corridor Abidjan Lagos*, *La Direction de la Santé de la Mère et de l'Enfant*, *le Programme National contre la Tuberculose*, and the United Nations Children's Fund (UNICEF).

After being delivered to CAME, the ACTs and RDTs are collected by distribution depots or sent to one of the two regional CAME depots. The regional distribution depots collect their stock from these regional CAME depots. From there, the products are collected by the health centers and hospitals. See figure 1 in the “Data Analysis” section below for an illustration.

On the ground, PNLP manages stock distribution monitoring in collaboration with zonal supervisors. Pre-shipment testing is not carried out by suppliers. Product quality control is carried out by LNCQ. LNCQ charges PNLP for testing products.

Costing Methodology

Sample Site Selection

Sample site regions were selected based on a list of existing health facilities from 2012 paired with information on population density available from the GeoData Institute to select a study region. Specific facilities were chosen in-country with the help of CAME. The final facility selection is listed in annex A, “Benin Survey Sites.” Annex B lists depot and health facility specifications.

Data Collection

Data collection was carried out during two weeks in November 2013. During this time, the team met with representatives of PNLP, the organization responsible for procurement activities and for coordinating quality control and with CAME. Follow-up of missing information and clarification was done via e-mail and telephone.

In addition to these organizations, an assessment of 22 health establishments was done in three departments of Benin: Atacora, Borgou, and Littoral-Atlantique. These establishments consist of zonal depots, zonal hospitals, mission hospitals, and health centers. In total, 25 sites were assessed as part of the study, in addition to PNLP.

Data Analysis

Distribution of ACTs and RDTs in Benin

Figure 1 demonstrates the flow of health goods through the public health supply chain in Benin. The zonal depots stock a supply for one hospital and multiple community centers in the health zone.

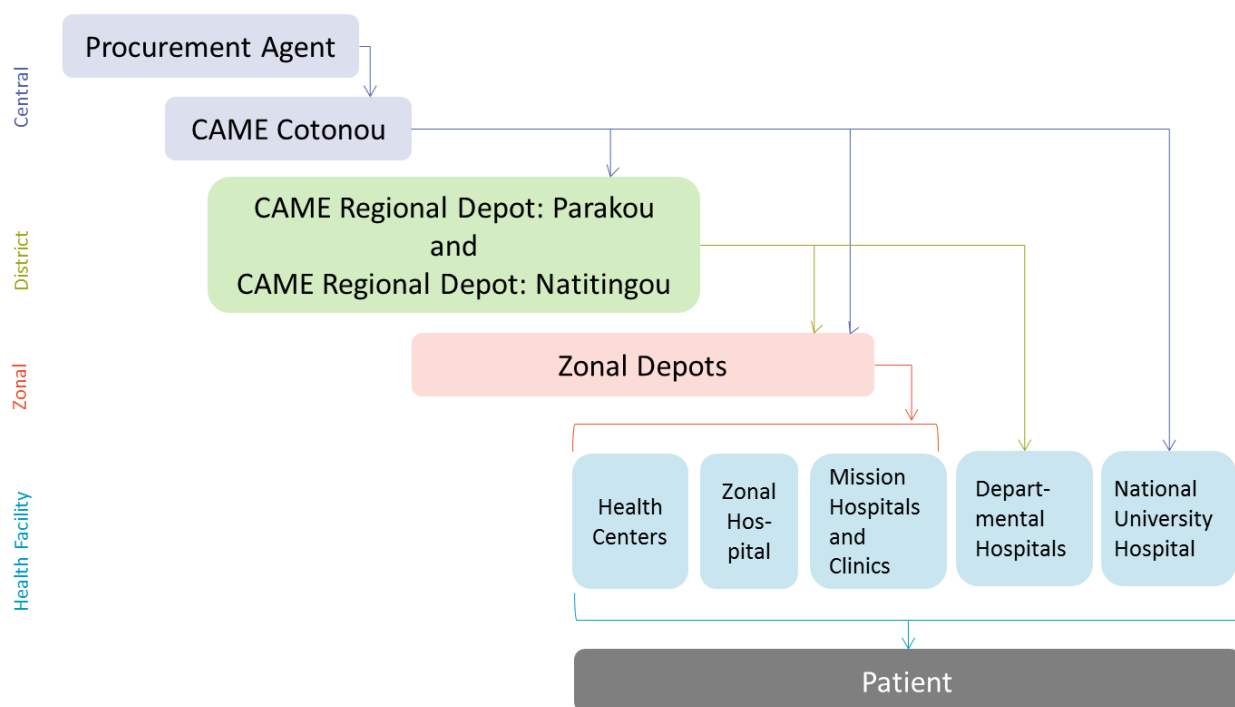


Figure 1. Distribution of ACTs and RDTs in Benin

The quantity and value of the ACTs and RDTs that pass from CAME to patients comes from CAME procurement documents between July 2012 and July 2013. The ACTs included in the study are packs of artemether and lumefantrine (AL) 20 mg/120 mg of 6, 12, 18, and 24. The RDTs included in this study are RDT malaria P.f and the RDT malaria Ag boxes of 25 tests (table 4).

Table 4. Total Volume of ACTs and RDTs Distributed by CAME

	SKU	Volume per Treatment Pack (m ³)	Treatment Packs Distributed to Next Tier (Quantity)	Total Volume Distributed (m ³)
Coartem AL tablets 20/120mg	Blister of 6	0.000066	104,256	6.9
	Blister of 12	0.000066	62,009	4.1
	Blister of 18	0.000157	99,233	15.6
	Blister of 24	0.000157	167,156	26.3
RDT malaria	Ag B/25	0.000061	273,550	16.8
	Ag P.f/Pan B/25	0.000061	52,500	3.2
	P.f	0.000061	71,125	4.4

Total volume was calculated according to the distribution of commodities at each tier. The volume in cubic meters (m³) was known for 90% of demand passing through CAME warehouses. At lower tiers exact volumes of commodities were unknown. If this volume was unknown, simple heuristics were used to estimate likely products distributed based on the knowledge of the supply network demonstrated in figure 2. Volume was calculated according to flow from CAME to depot to health facility. Although hospitals and health centers would at times go to CAME for stock, doing so was heavily discouraged by CAME.

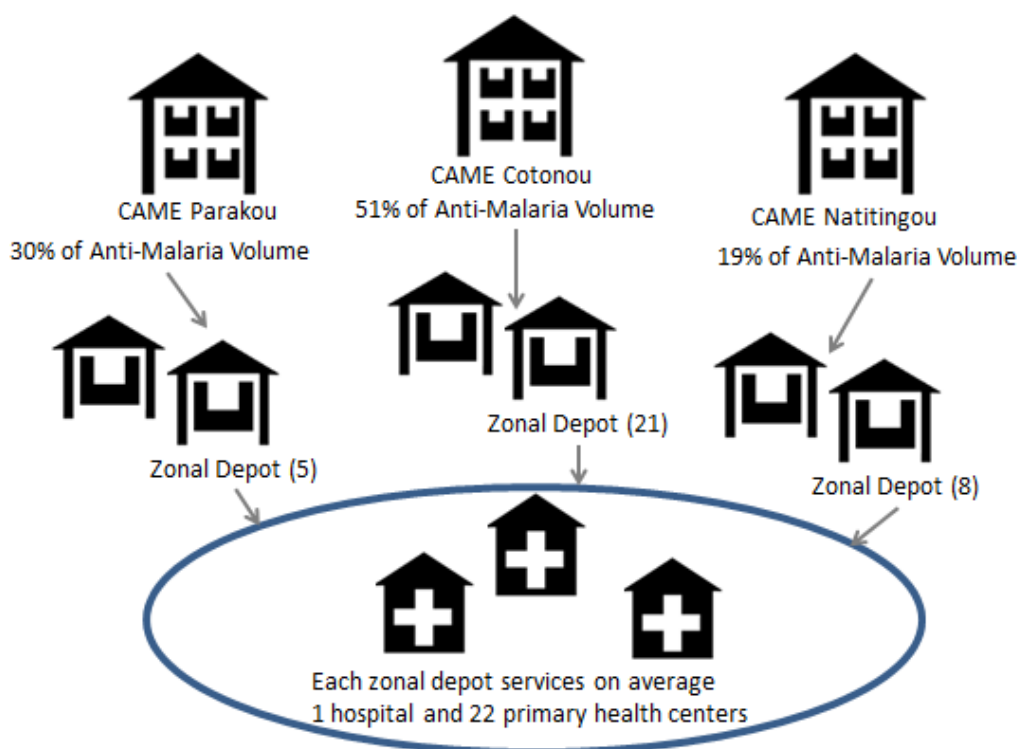


Figure 2. Benin product flow

Estimations of total volume distributed by CAME were determined using data provided by CAME on the total quantity of pharmaceuticals and antimalarial commodities shipped to the regional warehouses and the volume requisitioned by the zonal depots. Using this measurement, depots represented 12% of the demand for CAME's general pharmaceutical products; however, depots represented 94% of the demand for ACTs and 98% of the demand for RDTs. Although total procurement data were available in detail for the depots procuring from the CAME Cotonou warehouse, data were unavailable at the time of the interview for the CAME warehouses in Parakou and Natitingou. To determine the total volume received by these facilities, we used the average proportion of ACTs and RDTs to total volume of all commodities.

To calculate the total volume going to hospitals and primary health centers (PHCs), we analyzed how many health centers and hospitals were serviced by each province. In total, 823 public health facilities were reported operating in Benin with an average of one hospital and 22 health centers per health zone.

We used these data coupled with known demand data from a hospital and health center in Cotonou to develop a heuristic of 30% of depot volume going to hospitals and 70% of volume split across the other health centers being serviced.

Central Level Procurement

Procurement of ACTs and RDTs for the public sector in Benin is done mainly with donated funds and covers the contract with manufacturers, purchase, and insurance until the delivery of

the products to CAME. PNLP is responsible for coordinating the purchase of antimalarial products with PMI, the Global Fund (including Africare and Catholic Relief Services [CRS]), World Bank, and UNICEF. On the ground, PNLP manages stock distribution monitoring and pharmacovigilance. In this study, stock and pharmacovigilance monitoring are separate from the costs considered in distribution. The activities included in our research are the procurement activities, product quality control testing, and final authorization for distribution.

For the procurement process, the PNLP makes an announcement in the local media for products financed by CRS and Africare. When products are financed by PMI, they are procured through USAID | DELIVER and do not incur advertising costs. In 2013, the delivery of ACTs was through CRS and Africare, so these costs were used in the analysis. That same year, the delivery of RDTs was through PMI and therefore did not incur costs for inclusion in this study—which is why they were calculated as zero in table 5. The advertising costs in 2013 were about USD 100 (50,000 CFA) per announcement which is published in the main paper. The tender is evaluated by eight people: one pharmacist, one accountant, and one logistician from CAME, two people from PNLP, one person from Direction de la Pharmacie et du Medicament (DPM), and two people from the Global Fund—either Africare or CRS. These individuals spend a total of three days per tender process. In 2013, two tenders were executed for antimalarial products. These costs are presented in table 5.

Table 5. Central Level Procurement Costs of ACT and RDTs^a

Category	Total Cost for ILPs (USD)	Cost by Quantity–ACT (USD)	Cost by Quantity– RDT (USD)
Announcement of tenders	202	0.0007	—
Labor	2,617	0.0091	—
Total cost (USD)	2,819	0.0098	—
Total cost (CFA)	1,393,061	4.8447	—

^aThe conversion rate applied to the CFA franc in this analysis is 494.11 CFA per USD. This exchange rate is the average for 2013, calculated on oanda.com.

Product Quality Control

Quality control costs are incurred by production batch. LNCQ charges PNLP for testing products as follows:

- USD 160 (80,000 CFA) for each batch ACT—a sample of 100 tablets per batch is taken.
- USD 200 (100,000 CFA) per batch of injectables or RDTs—4 boxes of 25 are sampled and then given to hospitals for use.

The capital costs of LNCQ for testing equipment was provided by PMI, which donated USD 15 million worth of testing equipment. As a donated item, the capital cost of this equipment was not depreciated or included in the cost estimate.

The cost estimate in table 6 was made according to quality testing performed by LNCQ on ACTs in 2013.

Table 6. Cost of ACT Quality Control

Currency	Number of ACT Lots Tested in 2013	Cost per Lot	Annual Cost
Costs in CFA	4	80,000.00	320,000.00
Costs in USD	—	161.91	647.63

The cost estimate in table 7 was made according to quality testing performed by LNCQ on RDTs in 2013.

Table 7. Cost of RDT Quality Control

Currency	Number of RDT Lots Tested in 2013	Cost per Lot	Annual Cost
Costs in CFA	10	100,000.00	1,000,000.00
Costs in USD	—	202.38	2,023.84

Central Level Transportation and Storage Costs

CAME Siege has a warehouse dedicated to the stock it receives from PNLP. Regional warehouses have enclosed spaces dedicated to antimalarials. For this reason, the assessment of cost at this level was specific to ACTs and RDTs. The highest cost incurred at this level was labor followed by transportation costs.

Labor

The CAME antimalarial commodity stores use both part-time laborers and full-time employees. Full-time labor consists of one store manager and a few storekeepers at each of the three CAME locations—all of whom are dedicated to antimalarials. CAME has plans to increase the number of storekeepers in the ACT shop in 2014. Salaries are shown in table 8.

Table 8. Salary for Full-Time Employees at CAME Antimalarial Stores

Position	Average Monthly Salary (USD)	Average Monthly Salary (CFA)	Staff at Cotonou	Staff at Parakou	Staff at Natitingou
Store manager	1,113.11	550,000	1	1	1
Storekeeper	556.56	275,000	3	2	2

The costs in table 8 do not include health insurance payments, which as a rule do not exceed 230,000 CFA per year per employee. The store manager cost, however, may include allowances.

Part-time laborers are employed for entry of new stock and loading trucks for distribution to the facilities in Parakou and Natitingou. Each event requires 10 laborers for one day. Each laborer is paid 2,000 CFA per day; however, this amount is projected to increase to 3,000 CFA in 2014. In 2013, there were three stock entry events for ACTs and RDTs arriving from PNLP, CRS, and UNICEF, respectively. Four shipments of ACTs and RDTs occurred, along with ARVs—which constituted one-third of the total volume. (See table 9.)

Table 9. Cost for Part-Time Labor at CAME

Event	Number of People Required	Cost per Day (CFA)	Number of Days Employed	Percentage of Time Attributed to ACT, RDT	Cost Attributed to ACT, RDT (CFA)	Cost Attributed to ACT, RDT (USD)
Stock arrival	10	2,000	1	100%	20,000	40.48
Stock loaded and shipped	10	2,000	1	66%	13,200	26.71

Transportation to Regional Sites

Antimalarial shipments are made separately from regular pharmaceutical shipments. A 15-ton truck makes a quarterly trip from Cotonou to Parakou to Natitingou. The cost per shipment is 900,000 CFA: 650,000 CFA to Parakou and an additional 250,000 CFA to Natitingou. These shipments consist of antimalarials and antiretroviral medicines. Among these products, antimalarials occupy two-thirds of the total space due primarily to the large box sizes for these products. Each trip of antimalarials costs approximately 600,000 CFA per trip and 2,400,000 CFA per year.

Calculations

Costs provided by CAME in some cases represented the entirety of CAME, such as insurance and training. Other costs, such as utilities, were specific to the operations of the warehouses in Cotonou, Natitingou, and Parakou. Still other costs, such as labor, were specific to each warehouse's management of antimalarials. These specifications were determined for each cost and measured by the volume of products covered under that cost. For instance, insurance was broken down by the total value of all products managed by CAME; utilities were broken down by the special occupancy of the products measured; and labor was broken down by the volume of antimalarials receiving that resource.

Table 10 presents the costs incurred by CAME at each of its warehouses. The costs considered include insurance for commodities; utilities; labor; security; other selling (distributing), general, and administrative expenses (SG&A); IT maintenance; equipment maintenance; warehouse rent; IT depreciation; equipment depreciation; warehouse depreciation; and transporter payments as they relate to ACTs and RDTs.

Table 10. CAME Costs per Cubic Meter of ACTs and RDTs

Category	Cost per m ³ of Product (USD)	
	CAME Cotonou	CAME Parakou/Natitingou
Insurance for commodities	0.13	—
Utilities	4.90	5.11
Labor	439.23	351.79
Security	0.66	7.55
Other SG&A	0.13	0.13
Maintenance—IT	0.13	0.13
Maintenance—equipment	0.72	0.72
Rent—warehouse	—	—
Depreciation—IT	7.18	7.13
Depreciation—equipment	0.24	0.01
Depreciation—warehouse	0.09	—
Transportation costs	—	31.96

Insurance was calculated just from the central store in Cotonou, though this cost could be distributed across the other stores because they also store commodities covered by this plan. CAME owns all its warehouses, so warehouse rent equals 0. In Parakou and Natitingou, warehouses had fully depreciated. In Parakou, equipment had fully depreciated. In Cotonou, transportation costs were not incurred for receiving commodities and depots traveled to the store to pick up their orders. ACTs and RDTs were sent to Natitingou and Parakou, so the cost is attributed to these locations.

IT depreciation costs are high in comparison to warehouse. This calculation is based on self-reported data. CAME uses the Sage100 ERP platform for stock management. This platform was bought in 2000 and installed throughout CAME headquarters as well as CAME Parakou and Natitingou. Upgrades over the last 15 years have occurred in 2007 and 2013 to maintain service from the software company. The latest software update was to version E7 in 2013 and cost USD 15,932,023 (12,000,000 euro). The previous upgrade was in 2008, so the software depreciation is calculated at 5 years.

Zonal and Health Facility Transportation and Storage Costs

Data were gathered from six distribution depots, five hospitals, and 11 health centers. This information was used to estimate the distribution costs at each level. The next few pages are dedicated to the calculations made to determine the costs incurred by these facilities and directly related to the distribution of ACTs and RDTs. Based on the available information, we made certain assumptions to focus specific costs associated with each facility's storage capabilities. When specific costs elements were not directly available, costs were substituted using a heuristic based on information from comparable scenarios at other facilities. These assumptions are documented in the relevant annexes.

See table 11 for a summary of total costs dedicated to transporting and stocking commodities at the zonal depots surveyed.

Table 11. Annual Cost to Store All Commodities at Each Depot Surveyed

Depot	Annual Facility Costs Dedicated to Stock (CFA)	Annual Facility Costs Dedicated to Stock (USD)
<i>Dépôt Répartiteur de Zone</i> (DRZ) Natitingou	6,426,539.87	13,006.27
DRZ Ouidah	4,320,440.50	8,743.87
DRZ Cotonou 6	4,712,872.67	9,538.08
DRZ Cotonou 2 and 3	2,946,772.67	5,963.79
DRZ Tchaourou	3,974,621.96	8,043.99
DRZ Parakou-N'Dali	2,754,200.00	5,574.05

Table 12 provides a summary of total costs dedicated to transporting and stocking commodities at the hospital and community clinic levels surveyed. Three of the five hospital operating costs were significantly higher than those at the depots. Depots often experienced lower costs because they were located on compounds with a hospital, health clinic, or both. In these cases costs, such as security, were born by the hospital or clinic and not included in the operating costs of the depot. Furthermore, labor costs at the hospital level were higher. These higher costs could be attributed to salary and the fact that more than one person was involved in inventory management.

Table 12. Annual Costs to Store Commodities at Each Health Facility Surveyed

Health Facility	Annual Facility Costs Dedicated to Stock (CFA)	Annual Facility Costs Dedicated to Stock (USD)
<i>Hôpital de Zone</i> (HZ) St Jean de Dieu de Boko	3,220,608.97	6,517.99
HZ Natitingou	7,307,096.20	14,788.37
HZ Menontin	10,193,903.73	20,630.80
HZ Calavi	9,511,713.00	19,250.15
<i>Hôpital Confessionnel</i> (H conf) Ste Bakhita Natitingou	1,855,033.33	3,754.28
<i>Centre de Santé</i> (CS) Zongo II	2,349,377.40	4,754.76
CS Zogbo	2,949,300.00	5,968.90
CS Tourou	2,254,962.00	4,563.67
CS Toucouteuna	1,946,430.00	3,939.26
CS Parakou	1,106,346.00	2,239.06
CS N'Dali	1,661,472.67	3,362.55
CS Natitingou	4,835,500.00	9,786.26
CS Kpébié	2,990,856.30	6,053.00
CS Houénoussou	1,753,500.00	3,548.80
CS Cotonou 6	3,256,888.50	6,591.41
CS Boukoumbé	3,098,533.33	6,270.93

At the health zone and community levels, distribution depot costs were calculated for insurance, utilities, labor, security, IT maintenance and depreciation, equipment maintenance and depreciation, warehouse depreciation, and transportation as enumerated below. Depots were responsible for picking up commodities from the nearest CAME warehouse.

Depot Distribution Costs

- **Insurance:** No facilities paid insurance.
- **Utilities:** The median annual cost across depots was USD 903. For hospitals, the median was USD 6,002, which was the highest cost contributor for hospitals. For clinics, the median was USD 607. See annex C for full data set and explanation of calculations.
- **Labor:** Labor costs account for the highest cost contributors at the depot and clinic levels. The median annual labor cost across depots was USD 3,155. For hospitals, the median was USD 3,226. For clinics, the median was USD 1,918. See annex D for full data set and explanation of calculations.
- **Security:** The median annual security cost across depots was USD 384. For hospitals, the median was USD 1,760. For clinics, the median was USD 108. See annex E for full data set and explanation of calculations.
- **Transportation:** The median annual transportation cost across depots was USD 112. For hospitals, the median was USD 427. For clinics, the median was USD 291. The low cost is partly due to the vehicle being used once per month to retrieve stock, meaning the other days of the month were not included in the total cost. See annex F for full data set and explanation of calculations.
- **IT maintenance and depreciation:** The Ministry of Health installed a program for all facilities in 2011 and 2012 specifically to manage malaria commodities. The health facilities had no other updates to report, and maintenance costs were documented at zero. All facilities had computers, so depreciation value was USD 2,226 for all facilities, given that the tool was specific to malaria distribution and within the number of years before full amortization. See annex G for full data set and explanation of calculations.
- **Equipment maintenance and depreciation:** All facilities and depots reported no maintenance costs. The median depreciation value for depots was USD 185. For hospitals, the median was USD 80. For clinics, the median was USD 14. See annex H for full data set and explanation of calculations.
- **Warehouse depreciation:** Among the 22 depots and facilities visited, half of the warehouses had fully depreciated. Of those facilities with depreciating structures, the median depreciation value for depots was USD 1,012. For hospitals, the median was USD 115. For clinics, the median was USD 506. See annex I for full data set and explanations.

Unit Costs of ACTs and RDTs at Depots, Hospitals, and Health Centers

From these cost estimates, an average cost was derived by taking each depot and facility cost and weighting it to the number of ACTs and RDTs procured by that health facility. A weighted average was deemed most appropriate to provide more weight to those channels that handle a greater volume of product and are therefore more representative of expected costs. This cost was

then divided by the median ($M\tilde{x}$) volume of commodities procured to obtain a per unit cost that could be attributed to either ACTs or RDTs. In the case of labor costs related to ACTs, for every health center or hospital (subscript i), the formula is represented as follows:

$$\frac{\sum(Labor\ Cost_i \times Total\ ACT\ Volume\ Procured_i) / \sum(Total\ ACT\ Volume\ Procured_i)}{(M\tilde{x}(Total\ Volume\ Procured_i))} \times v_{ACT}$$

This same calculation was made for each of the cost factors presented in the previous section: utilities, labor, security, depreciation of IT, depreciation of equipment, depreciation of the warehouse, and transportation. We applied this method for all facilities together as well as for hospitals and PHCs separately.

Total Distribution Costs

Among those costs present throughout the distribution of ACTs and RDTs in Benin, the highest are those at the final distribution level of health facility, followed by those costs incurred at central and regional levels. Figure 3 demonstrates the percentage of total distribution costs contributed by each tier.

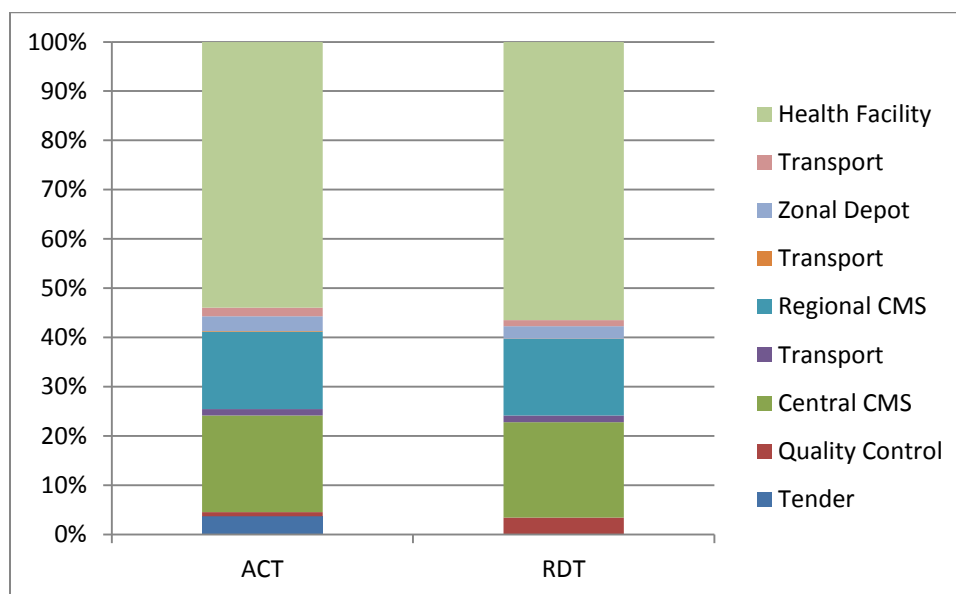


Figure 3. Percentage contribution of each activity level to distribution costs

The actual cost of each activity in the distribution chain for ACTs is broken down in figure 4. The x-axis presents cost in USD for one ACT treatment course. The y-axis presents each activity level the product passes through in order of distribution or occurrence. For example, a treatment course of ACT will first be stored at the CMS (CMS), then transported to a regional warehouse

(Transport), stored at the regional warehouse (Regional Warehouse), transported to a zonal store (Transport), etc.

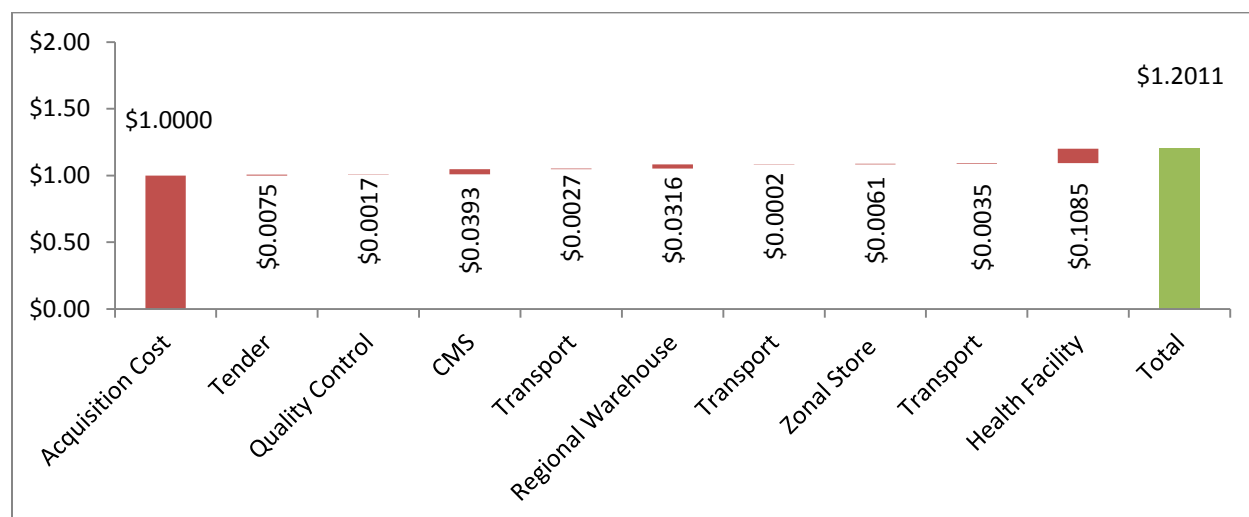


Figure 4. Waterfall diagram of distribution costs for ACTs

With some subtle differences, each activity contributes the costs illustrated in figure 5 to the distribution of RDTs.

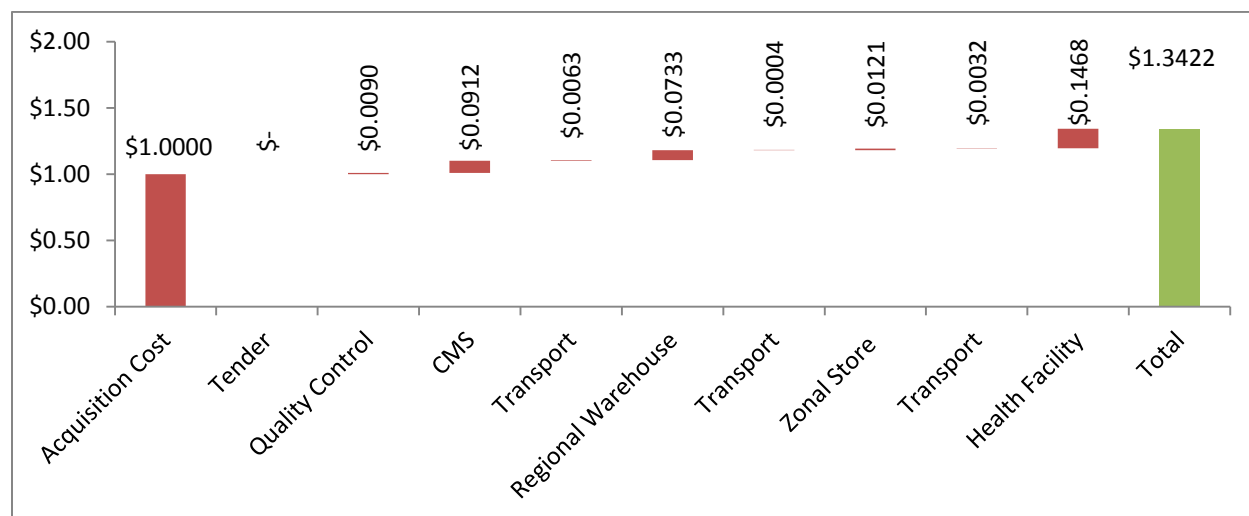


Figure 5. Waterfall diagram of distribution costs for RDT

The difference in proportion of cost allocation between RDTs and ACTs is partly due to the costs incurred by those facilities weighted by a larger distribution volume of the respective products.

These costs were analyzed further according to activity and cost driver. This analysis provided insights into developing the extrapolative model.

Cost Analysis

The analysis of costs was broken down in two ways focused on cost drivers. The first was to analyze those tiers that incurred the greatest cost. The second was to analyze those cost drivers present within the tiers that most affected cost.

In Benin, the total cost was most influenced by health facilities followed by CAME warehouses. To further analyze the costs incurred at the health facility level, facilities were divided according to hospitals and health clinics and according to rural and urban facilities. Table 13 provides a summary of the distribution costs previously outlined.

Table 13. Distribution Cost Summary: All Health Facility Costs Considered Equally (USD)

All	ACT	RDT
Acquisition cost	1.0000	1.0000
Tender	0.0075	—
Quality control	0.0017	0.0090
Central CMS	0.0393	0.0504
Central CMS transport	0.0027	0.0035
Regional CMS	0.0316	0.0404
Regional CMS transport	0.0002	0.0002
Zonal depot	0.0061	0.0066
Zonal depot transport	0.0035	0.0032
Health facility	0.1085	0.1468
Total	1.2011	1.2601
Percentage of acquisition cost	20%	26%

This estimate provides an understanding of all costs at the final tier when considered equally; however, health clinics were much more expensive than hospitals for storage per unit of product. Although the overall operating costs of a hospital were more, once the total volume of products being stored at the facilities was considered, clinic storage costs were approximately six times the cost of storage at hospitals; RDTs required four times the expenditure. This can be primarily attributed to a lower volume passing through the health clinic than the hospital. Since cost factors were primarily utilities and labor, these elements required measurement via volume. Table 14 provides a summary of the distribution costs where costs specific to hospitals and clinics are weighted according to the total number of each health facility type:

Table 14. Distribution Cost Summary—Distinction Made between Hospitals and Health Clinics (in USD)

Hospital/PHC	ACT	RDT
Acquisition cost	1.0000	1.0000
Tender	0.0075	—
Quality control	0.0017	0.0090
Central CMS	0.0393	0.0912

Hospital/PHC	ACT	RDT
Central transport	0.0027	0.0064
Regional CMS	0.0316	0.0731
Regional transport	0.0002	0.0004
Zonal depot	0.0061	0.0122
Hospital transport	0.0003	0.0010
Hospital	0.0169	0.0399
PHC transport	0.0060	0.0031
PHC	0.1112	0.1487
Total	1.1443	1.2643
Percentage of acquisition cost	14%	26%

The decrease in distribution cost was even more dramatic when considering urban and rural facilities. Although transportation costs between depot and health facility were low in Benin, transportation costs to rural facilities were approximately 40% higher than those in urban areas. Additionally, operating costs in rural areas were approximately 20% more than those in urban areas for ACTs. RDT distribution costs are less in rural than urban areas, probably because of the weighting of costs according to RDT volumes. Within the sample of facilities interviewed, the warehousing and equipment had fully depreciated. Nonetheless, when considering overall operating costs for rural compared to urban facilities, rural facilities incurred the higher cost.

As in the case of the hospital/PHC distinction, volume does play a factor. Urban facilities, however, procure 30% more ACTs and RDTs than rural facilities, much less than the 200% difference in the case of hospitals to clinics. Table 15 provides a summary of the distribution costs in which costs specific to urban and rural facilities are weighted according to the total number of each health facility type.

Table 15. Distribution Cost Summary—Distinction Made between Hospitals and Health Clinics (in USD)

Urban/Rural	ACT	RDT
Acquisition cost	1.0000	1.0000
Tender	0.0075	—
Quality control	0.0017	0.0090
Central CMS	0.0393	0.0912
Central transport	0.0027	0.0064
Regional CMS	0.0316	0.0731
Regional transport	0.0002	0.0004
Zonal depot	0.0061	0.0122
Urban transport	0.0009	0.0009
Urban	0.0290	0.0402
Rural transport	0.0012	0.0005
Rural	0.0297	0.0219
Total	1.1043	1.2071
Percentage of acquisition cost	10%	21%

The data in table 15 would suggest that when all facilities are considered equally, the high-cost facilities may be skewing the overall cost assessment. Considering the overall distribution of

facilities by type and geography can affect distribution assessments. In the case of Benin, this consideration can decrease the cost estimate by as much as 10%.

This analysis suggests that urban facilities had different costs than rural ones. Due to the small sample of RDTs passing through rural facilities, these cost estimates did not have as a great an impact.

For each activity level, a few cost drivers stand out from the rest. At the level of storage, these are labor and utilities. In the case of ACTs, labor costs account for 58% of the total distribution costs. Utilities come in second, accounting for 23% of cost. For RDTs, labor costs account for 65% of costs with utilities coming in second at 16%. The primary utility driving this cost was electricity. Transportation accounted for 3% of total costs; however, within this activity the primary cost driver was fuel costs, which accounted for over 20% of total transportation cost. Figure 6 represents 99% of all factors contributing to ACT distribution costs.

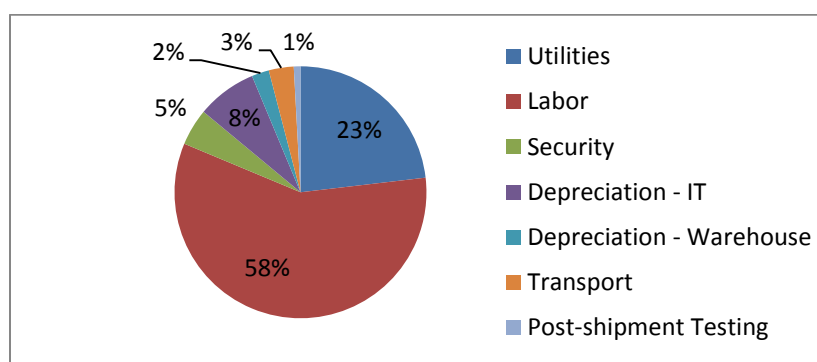


Figure 6. Breakdown of cost drivers for ACT distribution

Figure 7 shows 99.5% of all factors contributing to RDT distribution costs.

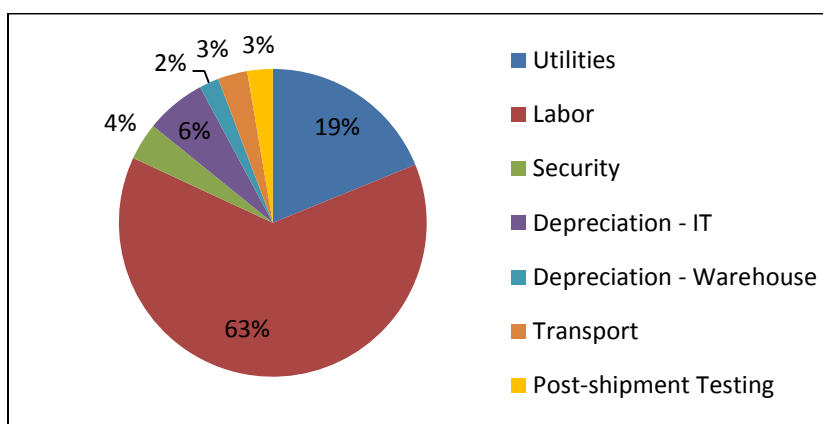


Figure 7. Breakdown of cost drivers for RDT distribution

KENYA

Supply Chain Structure: Procurement and Distribution of ACTs and RDTs

AL is the first-line treatment for uncomplicated malaria in Kenya, and together with RDTs, AL is procured using resources from the Global Fund and PMI.

At the time the study was conducted, KEMSA was a parastatal organization that manages procurement, warehousing, and distribution of medicines and health products to the public sector in Kenya. It also stores and distributes products procured by other donors such as PMI and the Global Fund. KEMSA has two warehouses in Nairobi: Embakasi, from which the majority of commodities are distributed, and Mombasa Road, which distributes select program commodities using courier services. Eight regional depots, located in Eldoret, Garissa, Kakamega, Kisumu, Meru, Mombasa, Nakuru, and Nyeri, function as storage units with no distribution of products. In some instances when facilities do not have enough storage space, an arrangement is made with KEMSA to store the surplus in a depot close to them.

Until 2007, KEMSA operated provincial depots, which served as intermediate storage and distribution tiers, but after a review of KEMSA's operations, the provincial depots were replaced by direct distribution to health facilities. In 2010, the Kenyan Constitution created 47 devolved county governments replacing the previous provinces and districts. These local governments became operational in 2013, and in late 2013, the health function also devolved. Since then, some counties are opting to procure the commodities from either the Mission for Essential Drug Supplies or KEMSA and in some cases private suppliers and then either storing them at the county store or sending them directly to the facilities. In addition, plans are under discussion to create three regional distribution centers to optimize the efficiency of the network. At the time of this study, however, KEMSA was still the central procurement agency distributing products directly to the public facilities. Similarly, ACTs and RDTs in Kenya were procured, stored, and distributed by KEMSA directly to the hospitals and health centers that provide these products to patients. (See figure 10 in the "Data Analysis" section below.)

KEMSA uses third-party transport service providers to supply directly to all public hospitals, rural health centers, and dispensaries throughout the country. KEMSA receives funding from the government and development partners for procurement of medical supplies for rural health facilities (4,000 dispensaries and 511 health centers operated by both the Government of Kenya and faith-based organizations). KEMSA's 2010–11 government budget for the procurement of essential medicines for public hospitals and rural health facilities was 49.5 million USD.

Product quality control is carried out by the NQCL. Pre-shipment testing is carried out by the suppliers at their own cost. No post-shipment testing is done, but post-marketing surveillance is carried out once or twice a year by the national PPB in collaboration with DoMC and NQCL. PPB selects samples of antimalarial products from select sites on the market and uses a minilab to test quality.

Costing Methodology

Sample Site Selection

This study used 2008 GPS data on the location of health facilities in Kenya to select a study sample. GPS data were limited to Ministry of Health facilities (i.e., district and sub-district hospitals, health centers, and dispensaries). The three provinces selected were Nairobi, Nyanza, and Coastal. The final facility selection is listed in annex J, “Kenya Sample Sites.” Annex K lists hospital and PHC specifications.

Data Collection

Field data collection in Kenya took place over a three-week period in September 2013. During this time, the project core team met with representatives at the two KEMSA national warehouses in Nairobi—the Headquarters warehouse on Mombasa Road and the Embakasi warehouse—as well as with representatives at the two regional warehouses in operation, Mombasa warehouse and Kisumu warehouse. KEMSA interviews provided key data inputs for costs associated with procurement, distribution, and warehousing for public sector health products. Figure 8 illustrates a typical KEMSA warehouse facility.

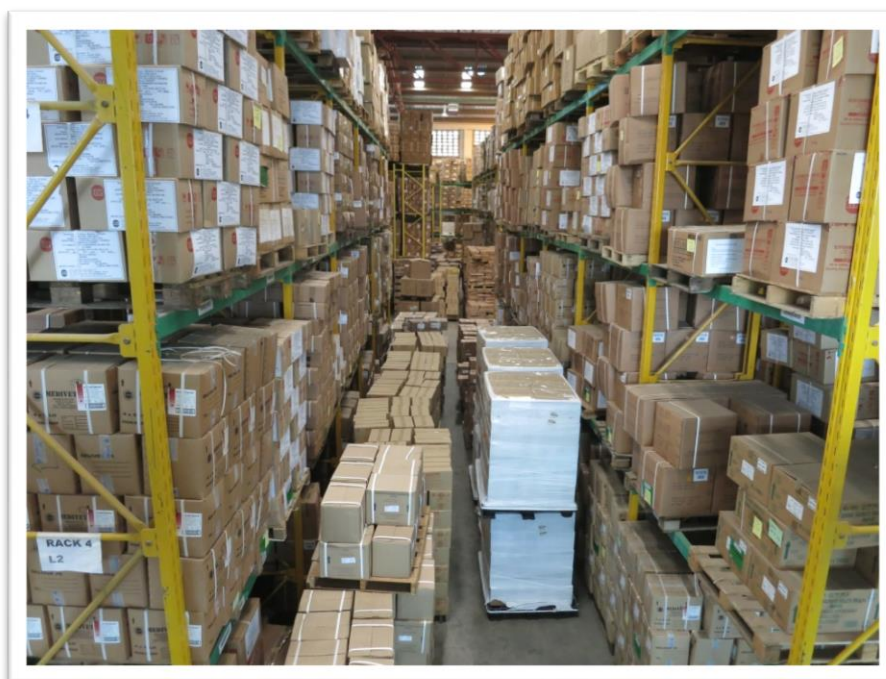


Figure 8. KEMSA warehousing facility

In addition, the project core team met with individuals responsible for quality assurance and control activities for ACTs, RDTs, and LLINs as well as a national representative from the CHW program.

Twenty-two health facilities (i.e., district and sub-district hospitals, health centers, and dispensaries) were surveyed across three provinces in Kenya. Facilities were surveyed in Mombasa (Coastal province), Homa Bay and Mbita (Nyanza province), and Nairobi (Nairobi province). The 22 health facilities combined with the three KEMSA warehousing sites totaled 25 sites where interviews were conducted. Before the completion of field research, follow-up visits were made with KEMSA to ensure all sources of data were obtained. Figure 9 illustrates storage at a dispensary site.



Figure 9. Health dispensary storage facility

Data Analysis

Distribution of ACTs and RDTs in Kenya

Figure 10 demonstrates the flow of health goods through the public health supply chain in Kenya.

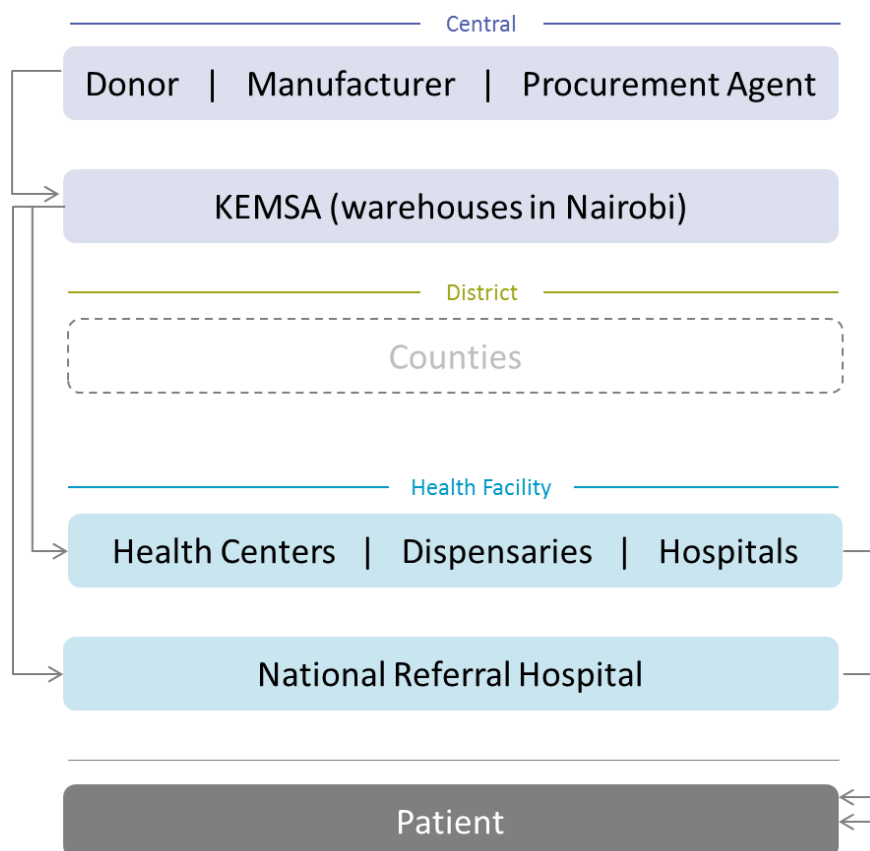


Figure 10. Distribution of medicines in the public sector in Kenya

The quantity and value of product flow from KEMSA to hospitals and PHCs was obtained from KEMSA shipment history for the period from July 2012 through June 2013. The ACTs included in the study are packs of AL 20 mg/120 mg of 6, 12, 18, and 24. The RDTs included in this study are RDT Care Start HRP two boxes of 60 tests. The total volume and value of these products are shown in table 16.

Table 16. Volumes Procured and Distributed by KEMSA

	SKU	Volume per Treatment Pack (m ³)	Treatment Packs Distributed to Next Tier (Quantity)	Total Volume Distributed (m ³)
AL tablets 20/120 mg	Blister of 6S	0.00007	4,283,600	282.5
	Blister of 12S	0.00007	3,300,210	217.6
	Blister of 18S	0.00016	1,352,311	212.9
	Blister of 24S	0.00016	6,043,238	951.6
	Care Start Malaria HRP 2 (P.f)	0.00006	7,227,960	431.0

The quantity of ACTs and RDTs was available through KEMSA procurement status reports. These volume data were used to estimate the cost per unit of product for different activities. For

instance, each ACT incurs a cost for the product quality control activities carried out in-country to test this product. To determine this per unit cost, the total cost of testing ACTs in a year was divided by the total number of units shipped from KEMSA for that same year. This produced the “Cost of ACT by Unit” number used in table 17.

This volume measure is for one base unit of product, which is the unit counted by KEMSA when registering distributions to health facilities.

Central Level Procurement

Central level procurement is based out of KEMSA. The primary costs of this activity are the advertising of tenders and labor costs of the procurement team. Products are shipped to KEMSA’s central warehouse in Embakasi by the manufacturer. Since this cost is covered in the contract for ACT and RDT purchases, it is not included in our calculation. According to KEMSA, 88 tenders were issued between July 2012 and June 2013. Of these, three were issued for ACTs and one for RDTs. The ratio of product specific tenders over total tenders was used to calculate the costs attributed to ACT and RDT commodities. This cost was then divided by the total quantity of the products procured. Table 17 presents this calculation.

When products are financed by PMI, they are procured through USAID | DELIVER and do not incur advertising costs. When financed by the Global Fund, the DoMC makes an announcement in the local media.

Table 17. Central Level Procurement Costs of ACTs and RDTs^a

Expenditure	Total Cost for All Commodities	Cost of ACT by Unit	Cost of RDT by Unit
Advertising of tenders (USD)	84,950.54	0.0002	0.0001
Labor (USD)	325,643.74	0.0007	0.0005
Total cost (USD)	410,594.28	0.0009	0.0006
Total cost (KSh)	34,800,000.00	0.0792	0.0547

^aThe conversion rate applied to the KSh in this analysis is 84.76 KSh per USD. This exchange rate is the average for 2013 as calculated on oanda.com.

Product Quality Control

Post-marketing surveillance is carried out by the national PPB in collaboration with the NQCL and the DoMC. The PPB selects samples of antimalarial products from select sites on the market and uses a minilab to perform tests on quality. In May 2013, the PPB reported that 17% of all level 1 tests were conducted on ACTs in the public sector. This percentage was used to segment the overall costs incurred by PPB in testing products and attribute the appropriate portion of costs to ACT blister packs (table 18).

Table 18. PPB Annual Quality Assurance Cost per Unit of ACT

Expenditure	Annual Cost	Cost per Sample	Cost of ACT in Public Sector by Unit
Transport (USD)	3,350.83	2.12	0.0001
Labor (USD)	6,996.62	4.43	0.0001
Other SG&A (USD)	1,736.77	1.10	0.0000
Total cost (USD)	12,084.21	7.65	0.0002
Total cost (KSh)	1,024,200.00	648.00	0.0165

According to the national strategy for testing, after passing through level 1 tests, 10% of products that pass the minilab test and 100% of those that fail or are classified doubtful are sent for a second test at the NQCL for verification of the basic tests. The PPB report stated that four batches of ACTs reached levels 2 and 3 and were subsequently tested by the NQCL. The costs incurred by these actions are calculated in table 19.

Table 19. NQCL Cost per Unit of ACT

	Number of Tests in 2013	Cost per Batch	Annual Cost	Cost of ACT by Unit
AL tablets (KSh)	4	35,200.00	140,800.00	0.0132
Total cost (USD)	—	415.31	1,661.26	0.0002

Manufacturers are required to complete preshipment quality assurance inspections with costs borne by them. Therefore the cost does not fall within the scope of this study. RDTs are not included in post-marketing surveillance campaigns by public institutions and, therefore, do not incur a cost at this time.

Central Level Transportation and Storage Costs

Based on multiple reports and interviews, annual costs and their contribution to ACT and RDT commodities were calculated for KEMSA and are presented in table 20. These costs include insurance for commodities, utilities, labor, security, other SG&A, IT maintenance, equipment maintenance, warehouse rent, IT depreciation, equipment depreciation, warehouse depreciation, and transporter payments.

Table 20. KEMSA Total Annual Costs for all Commodities

Expenditure	In USD	In KSh
Insurance for commodities	4,129.54	350,000
Utilities	172,104.32	14,586,736
Labor	1,679,691.35	142,362,576
Security	8,495.05	720,000
Other SG&A	163,513.08	13,858,584
Maintenance—IT	14,158.42	1,200,000
Maintenance—equipment	48,138.64	4,080,000
Rent—warehouse	14,158.42	1,200,000
Depreciation—IT	11,527.32	977,000
Depreciation—equipment	81,198.56	6,882,000
Depreciation—warehouse	—	—
Total cost	2,197,114.71	186,216,896

Unit costs were calculated according to the total cost figures provided by KEMSA divided by the total volume procured that year—with the exception of insurance. Warehouse depreciation costs were not included because the warehouses that stored ACTs and RDTs were rented.

Health Facility Transportation and Storage Costs

At the hospital and PHC level, seven cost categories were considered from the survey data collected: insurance, utilities, labor, security, IT maintenance and depreciation, equipment maintenance and depreciation, and warehouse depreciation. These costs were used to determine the total costs to store commodities at each health facility. The cost of transportation from KEMSA to the health facilities is incurred by KEMSA since KEMSA is responsible for all deliveries to health facilities.

Total storage costs are presented in table 21. These costs are calculated based on an expected appropriation of resources to all stocking activities within a year. The next few pages are dedicated to the calculations made to determine each of the seven cost components that make up the costs presented. Based on the available information, we made certain assumptions to focus specific costs associated with each facility's storage capabilities. When specific costs elements were not directly available, they were estimated using information from comparable scenarios at other facilities. These assumptions are documented in the relevant annexes.

Table 21. Annual Cost to Store All Commodities at each Health Facility Surveyed

Health Facility	Annual Facility Costs Dedicated to Stock (KSh)	Annual Facility Costs Dedicated to Stock (USD)
Rangwe Sub-district Hospital	69,726.15	822.68
Mbita District Hospital	276,260.42	3,259.51
Port Reitz District Hospital	30,086.38	354.98
Homa Bay District Hospital	19,686.68	232.28
Mbagathi District Hospital	29,276.14	345.42
Tudor District Hospital	34,007.43	401.24
Makongeni Health Centre	271,544.01	3,203.86
Miritini Constituency Development Fund (CDF) Dispensary	27,209.68	321.04
Lambwe Health Dispensary	128,020.80	1,510.48
Usao Health Centre	621,217.28	7,329.55
Mlaleo Health Centre	269,344.55	3,177.91
Makadara Health Centre	197,707.14	2,332.68
Miniambo Dispensary	110,942.82	1,308.98
Bahati Health Centre	423,927.48	5,001.79
Ngaira Dispensary	262,288.07	3,094.65
Special Treatment Center (STC) Casino Health Centre	473,303.79	5,584.36
Maweni Dispensary	146,487.82	1,728.36
Shimo La Tewa Annex Dispensary	112,485.49	1,327.18
Langata Health Centre	184,106.42	2,172.21
Tom Mboya Health Centre	269,786.51	3,183.13
Kitare Health Centre	102,035.67	1,203.89
Rariw Dispensary	269,324.60	3,177.68

At the hospital and other health facility level, distribution depots costs were calculated for insurance, utilities, labor, security, IT maintenance and depreciation, equipment maintenance and depreciation, warehouse depreciation and transportation as enumerated below.

- **Insurance:** No facilities paid insurance.
- **Utilities:** The median annual cost of utilities across all facilities was USD 80. For hospitals, the median was USD 330. For PHCs the median was USD 78. See annex L for full data set and explanation of calculations.
- **Labor:** Labor costs constitute the most significant distribution-related cost at the PHC and hospital level. Table 22 presents the labor costs estimated based on effort that was attributed to stocking and the total number of staff involved in stocking activities. Median annual labor costs attributed to stocking were USD 4,226.53. At hospitals, this median was USD 6,862, and at PHCs, the median was USD 3,445. See annex M for complete labor cost calculations.

Labor presented the biggest component to facility operating costs. Labor costs were on average 62% of total costs and contributed up to 87% of the total costs dedicated to stock at one facility. It should be noted that labor costs were calculated on the basis of self-reported hours on stock management, which may explain anomalies such as that documented at STC Casino Health Centre. Nonetheless, health centers represent the highest contribution; almost double that of the next highest costs represented by dispensaries. Although the salaries themselves are not unreasonably high, the high labor cost can largely be attributed to a high number of employees.

- **Security:** The median annual costs of security were USD 440. For hospitals, the median security costs were USD 1,123, and for PHCs the median costs were USD 422. See annex N for the full data set and explanation of security cost calculations.
- **IT maintenance and depreciation:** After reviewing survey data, we determined that only the hospitals incurred sufficient IT maintenance and depreciation costs to be included in this study. Although some health centers and dispensaries had computers, they were often donated and not used for stock-keeping purposes or not used at all. The median IT maintenance cost attributed to stock activities was USD 23, and the median cost attributed to IT depreciation was USD 1,056. See annex O for the full data set and explanation of IT maintenance and depreciation calculations.
- **Equipment maintenance and depreciation:** Eight facilities out of 22 reported equipment maintenance costs. Fifteen out of 22 facilities had equipment that was not fully depreciated. Of the values available for equipment depreciation, the median annual cost attributed to depreciation of equipment directly related to storage was USD 15. For hospitals, the median cost was USD 91, and for health centers it was USD 10. See annex P for the full data set and explanation of equipment maintenance and depreciation calculations.

- Warehouse depreciation:** One of the six hospitals surveyed had storage facilities that had not fully depreciated. Twelve of the 16 health centers and dispensaries had storage facilities that had not been fully depreciated. Three facilities surveyed were able to provide the initial cost of construction at their facility. For all other facilities, the initial capital investments were estimated as the median of the three health facilities that provided these data. The median depreciation rate for storage facilities was USD 682 per year. See annex Q for the full data set and explanation of warehouse depreciation calculations.

Table 22. Annual Labor Cost Dedicated to Stocking Activities

Facility Name	Total Staff Involved	Annual Salary Dedicated to Stock (KSh)	Annual Salary Dedicated to Stock (USD)
Rangwe Sub-district Hospital	1	460,800.00	5,436.83
Mbita District Hospital	4	1,806,000.00	21,308.43
Port Reitz District Hospital	7	1,110,900.00	13,107.16
Homa Bay District Hospital	3	738,000.00	8,707.43
Mbagathi District Hospital	1	960,000.00	11,326.74
Tudor District Hospital	2	460,749.60	5,436.24
Makongeni Health Centre	2	403,200.00	4,757.23
Miritini CDF Dispensary	2	105,750.00	1,247.71
Lambwe Health Dispensary	2	254,400.00	3,001.59
Usao Health Centre	3	1,438,080.00	16,967.45
Mlaleo Health Centre	1	835,944.00	9,863.04
Makadara Health Centre	3	843,750.00	9,955.14
Miniambo Dispensary	1	220,800.00	2,605.15
Bahati Health Centre	5	1,338,000.00	15,786.64
Ngaira Dispensary	2	930,000.00	10,972.78
STC Casino Health Centre	14	1,669,200.00	19,694.37
Maweni Dispensary	2	397,848.00	4,694.08
Shimo La Tewa Annex Dispensary	4	760,200.00	8,969.36
Langata Health Center	3	800,000.00	9,438.95
Tom Mboya Health Centre	4	606,000.00	7,150.00
Kitare Health Centre	2	686,640.00	8,101.45
Rariw Dispensary	1	432,000.00	5,097.03

Unit Costs of ACTs and RDTs at Hospitals and Health Centers

From these cost estimates, an average cost was derived by taking each facility cost and weighting it to the number of ACTs and RDTs procured by that health facility. A weighted average was deemed most appropriate to provide more weight to those channels that handle a greater volume of product. This cost was then divided by the median volume procured of commodities managed to obtain a per unit cost that could be attributed to either ACTs or RDTs. In the case of labor costs related to ACTs, the formula is represented as follows:

$$\frac{\sum(Labor\ Cost_i \times Total\ ACT\ Volume\ Procured_i) / \sum(Total\ ACT\ Volume\ Procured_i)}{(M \hat{x} (Total\ Volume\ Procured_i))} \times v_{ACT}$$

Total Distribution Costs

Among those costs present throughout the distribution of ACTs and RDTs in Kenya, the highest are those at the final distribution level of health facility. From the data available at each tier of distribution, we estimated the total landed cost of ACTs and RDTs. Figures 11 and 12 present these costs. In all cases, CMS refers to KEMSA. The costs presented here are based on data gathered in September 2013 and the distribution volumes of all products shipped from KEMSA from July 2012 through June 2014.

The actual cost of each activity in the distribution chain for ACTs is broken down in figure 11.

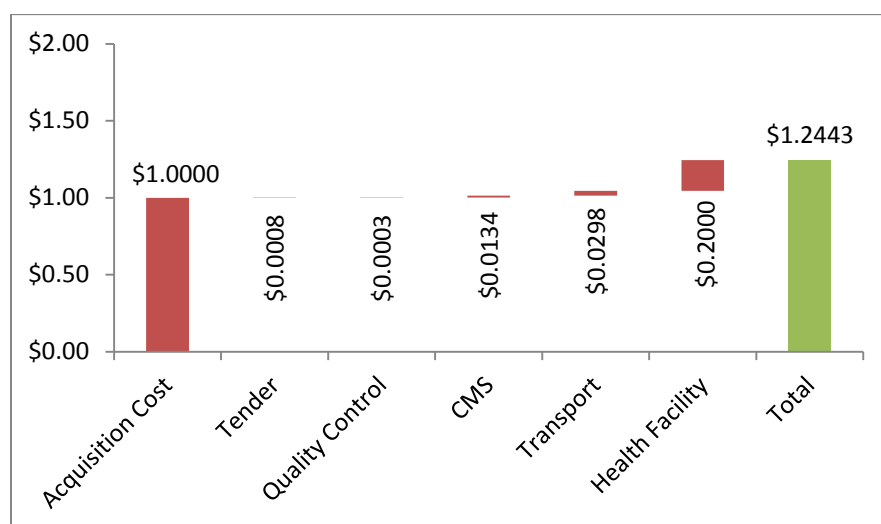


Figure 11. Waterfall diagram of distribution costs for ACTs

Each activity contributes the costs shown in figure 12 for the distribution of RDTs.

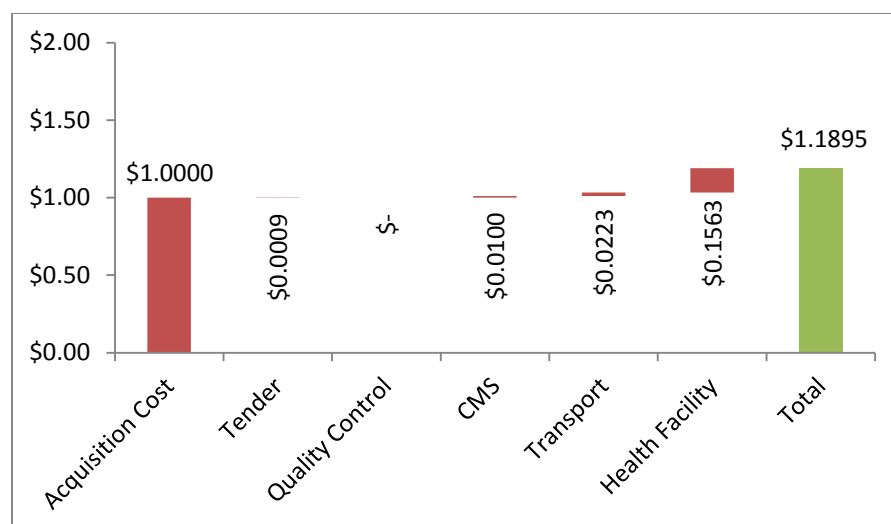


Figure 12. Waterfall Diagram of Distribution Costs for RDTs

These costs were analyzed further according to activity and cost driver. This analysis provided insights into developing the extrapolative model.

Cost Analysis

The analysis of costs was broken down in two ways focused on cost drivers. The first was to analyze those tiers that incurred the greatest cost. The second was to analyze those cost drivers present within the tiers that most affected cost.

In Kenya, labor and transportation were the major components of cost structure. To further analyze the costs incurred at the health facility level, facilities were divided according to hospitals and health clinics and segmented as per rural and urban locations. Table 23 provides a summary of the distribution costs previously outlined.

Table 23. Distribution Cost Summary—All Health Facility Costs Considered Equally (in USD)

All	ACT	RDT
Acquisition cost	1.0000	1.0000
Tender	0.0008	0.0009
Quality control	0.0003	—
CMS	0.0134	0.0100
Transport	0.0298	0.0223
Hospital and PHC	0.2000	0.1563
Total	1.2443	1.1895
Percentage of acquisition cost	24%	19%

In comparison, health clinics had much more expensive storage costs than hospitals. Although the overall operating costs of a hospital were higher, once the total volume of products being

stored at the facilities was considered, clinic storage costs were approximately six times the cost of storage at hospitals; RDTs, by contrast, required three times the expenditure. This difference can be primarily attributed to a lower volume passing through the health clinic than the hospital. Since the cost driver was labor, the respective cost measurement used was volume. The total volume of ACTs flowing through all health clinics was approximately three times that flowing through hospitals; however, clinics outnumber hospitals seven to one. Table 24 provides a summary of the distribution costs in which costs specific to hospitals and clinics are weighted according to the total number of each health facility type in the country.

Table 24. Distribution Cost Summary—Distinction Made between Hospitals and Health Clinics (in USD)

Hospital/PHC	ACT	RDT
Acquisition cost	1.0000	1.0000
Tender	0.0008	0.0009
Quality control	0.0003	—
CMS	0.0134	0.0100
Transport to hospital	0.0158	0.0118
Hospital	0.0397	0.0282
Transport to PHC	0.0315	0.0236
PHC	0.2184	0.1777
Total	1.1288	1.1027
Percentage of acquisition cost	13%	10%

Making a distinction between hospital and health facility resulted in lower costs per unit of product than considering the costs jointly. When making a distinction between rural and urban facilities, the cost estimate was closer to that which was inclusive of all facilities equally.

Operating costs were considerably higher in rural facilities than urban ones for ACTs and RDTs—about three times more for ACTs and for RDTs. Volume procured by urban facilities was five times greater than that procured by rural facilities. As in the case of the hospital/PHC distinction, volume does play a factor. Table 25 provides a summary of the distribution costs where costs specific to urban and rural facilities are weighted according to the total number of each health facility type.

Table 25. Distribution Cost Summary—Distinction Made between Urban and Rural Health Facilities (in USD)

Urban/Rural	ACT	RDT
Acquisition cost	1.0000	1.0000
Tender	0.0008	0.0009
Quality control	0.0003	—
CMS	0.0134	0.0100
Transport	0.0298	0.0223
Urban	0.0776	0.0533
Rural	0.1937	0.1593
Total	1.2338	1.1888
Percentage of acquisition cost	23%	19%

For each activity level, a few cost drivers stand out from the rest. At the level of storage, these drivers are labor and utilities. In the case of ACTs, labor costs account for 71% of the total distribution costs. Transportation comes in second, accounting for 12% of cost. For RDTs, labor costs account for 69% of costs with transportation coming in second at 12%.

Figure 13 represents 99% of all factors contributing to ACT distribution costs.

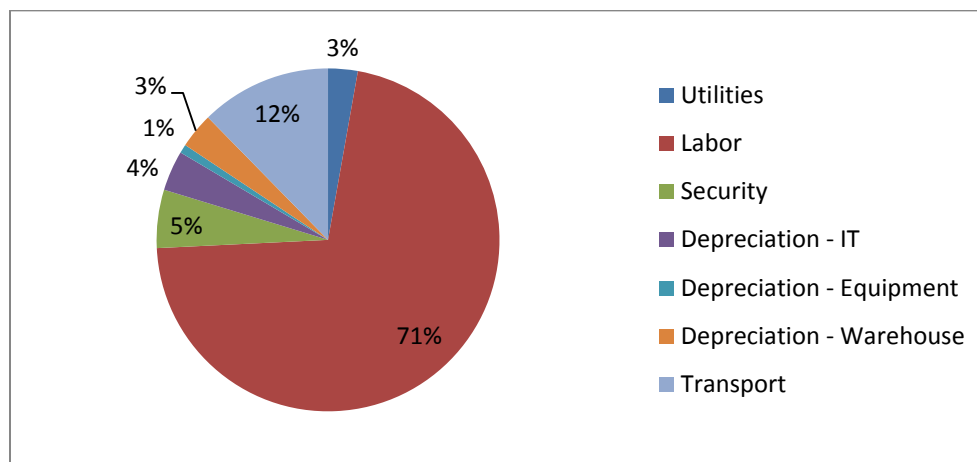


Figure 13. Breakdown of cost drivers for ACT distribution

Figure 14 shows 99% of all factors contributing to RDT distribution costs.

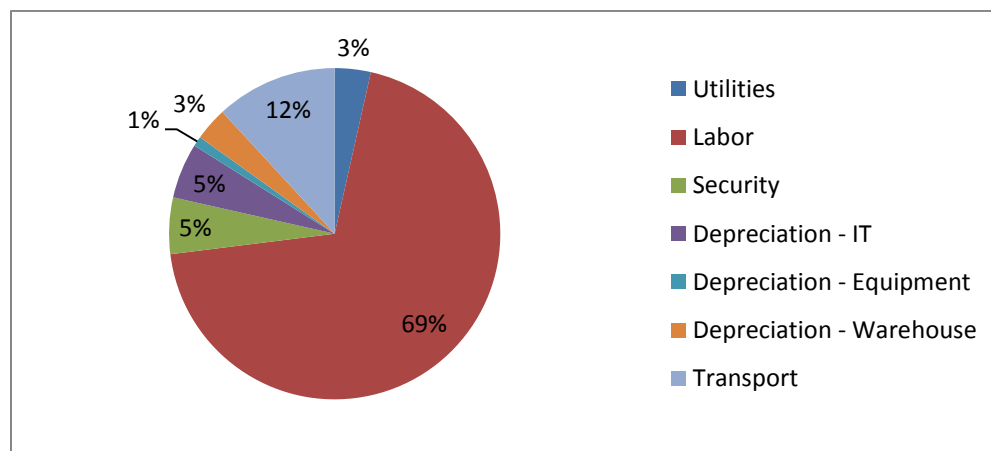


Figure 14. Breakdown of cost drivers for RDT distribution

Based on these cost drivers, we extrapolated labor hours and total kilometers. These elements will provide inputs in the extrapolative model to estimate distribution costs of countries other than Kenya.

CONCLUSIONS

Our findings indicate that distribution costs play a significant role in the costs of delivering ACTs and RDTs.

The study identified the major cost drivers in the distribution chain in Benin and Kenya as labor, utilities, and transport, as well as areas where a more in-depth analysis may be required to identify areas for cost considerations.

Our analysis also illustrates the importance of product volumes in supply chain costing with costs being very sensitive to changes in volumes distributed in cubic meters.

The findings can be used by planners and policy makers to allow accurate estimates for the costs for the delivery of malaria commodities to the end user and enable planning and budgeting in roadmaps and proposals. This also enables countries to demonstrate how much they are contributing to the distribution of medicines in addition to those funds donated. Donor funds are earmarked for physical distribution costs such as warehousing and transportation. This study finds that the greatest cost is labor, which is often financed by the government. By calculating the various costs along the supply chain, countries can better demonstrate their financial commitments to distribution.

RECOMMENDATIONS

- 1) Countries should use accurate distribution costing data when budgeting for malaria interventions
- 2) Product volumes should be considered when costing distribution rather than value
- 3) In future applications, more attention will be needed for obtaining accurate data while in-country.
- 4) Countries should avoid using percentages of total acquisition costs to estimate the costs of product distribution costs. This practice has the potential to introduce inaccuracies because percentage costs are often dependent on initial acquisition costs.
- 5) Planners and policy makers can use the information on cost drivers to conduct a more detailed analysis to determine how to increase efficiency and improve access to malaria commodities in low- and middle-income countries
- 6) Accurate costing of distribution is a highly resource- and time-intensive effort. Not all countries will have access to the resources needed. Therefore, developing a model to estimate distribution costs is likely to be embraced and used by stakeholders in the various levels, especially because acquiring detailed information requires a large resource investment to cost each tier and function.

Next Steps for Development of an Extrapolative Model

Given that storage and transportation are the largest cost contributors in the supply chain, and that labor, utilities, and fuel drive these costs, these factors are key in the formulation of the extrapolative model. To extrapolate these costs to a third country, several inputs are needed, some which are required and others that are recommended to specify the expected costs. If the recommended inputs are unavailable, proxy variables are used. Proxies are calculated based on those values calculated for Benin and Kenya. To estimate cost drivers for Sub-Saharan countries, we have divided these costs by minimum wage labor cost, the cost of electricity, and the cost per liter of fuel, respectively. This division resulted in the extrapolation of labor hours, kilowatt hours, and total liters required for distribution, which can be interpolated with country specific costs that are publicly available and easily accessible.

Costs outlined in the model and incurred directly by the Ministry of Health and CMS are likely to be more accessible to users. These cost activities include procurement, quality assessment, central warehousing, and transportation from the central warehouse to the next tier. Incorporating as many of these known costs as possible will improve the accuracy of the estimate.

Using the results from our analysis, we also developed cluster categories for the facilities visited based on the key factors that would affect distribution-related costs. Because costs vary

depending on type of facility, clusters were based on volumes received from KEMSA and similar factors. The objective is to have low variation in costs across facilities in one cluster and high variation across clusters. The analysis of costs in each cluster will be used to narrow down costs incurred by the various hospitals and PHCs in the national public sector. This same analysis can incorporate country specific distribution of facility types to create a more granular distribution-cost estimate.

ANNEX A. BENIN SURVEY SITES

The following table lists the health facilities visited in Benin. Each color represents a department (e.g. Atlantique-Littoral). The various tones highlight the facility type, from the darkest tone which represents the CAME warehouse to the lightest tone which represents a health center.

Type d'établissement	Département	Zone Sanitaire	Nom
Entrepôt	Littoral		CAME HQ
Dépôt répartiteur	Littoral	Cotonou 2- Cotonou 3	Dépôt répartiteur de zone Cotonou 2&3
Dépôt répartiteur	Littoral	Cotonou 6	Dépôt répartiteur de zone Cotonou 6
Dépôt répartiteur	Atlantique	Ouidah	Dépôt répartiteur de zone Ouidah
Hôpital de Zone	Littoral	Cotonou 5	Hôpital Menotin
Hôpital de Zone	Atlantique	Calavi	Hôpital de zone de Calavi
Centre de Santé	Littoral	Cotonou 6	Centre de santé Houénoussou
Centre de Santé	Atlantique	Cotonou 5	Centre de santé de Zogbo
Centre de Santé	Littoral	Cotonou 6	Centre de santé Cotonou 6
Entrepôt	Atacora	Natitingou	CAME Dépôt
Dépôt répartiteur		Natitingou	Dépôt répartiteur de zone Natitingou
Hôpital de Zone		Natitingou	Hôpital de zone de Natitingou
Hôpital Confessionnel		Natitingou	Hôpital Ste Bakhita Natitingou
Centre de Santé		Natitingou	Centre de santé de Natitingou
Centre de Santé		Toucountouna	Centre de santé de Toucountouna
Centre de Santé		Bokooumbe	Centre de santé de Boukoumbé
Entrepôt	Borgou	Parakou	CAME Depot
Dépôt répartiteur		Parakou	Dépôt répartiteur Parakou-N'dali
Hôpital Confessionnel		N'Dali	Hôpital de zone St Jean de Dieu de Boko
Centre de Santé		N'Dali	Centre de santé de N'dali
Centre de Santé		Parakou	Centre de santé communal de Parakou
Centre de Santé		Parakou	Centre de santé de Kpebié
Centre de Santé		Parakou	Centre de santé de Tourou
Centre de Santé		Parakou	Centre de Santé de Zongo II
Dépôt répartiteur		Tchaourou	Dépôt répartiteur Tchaourou

ANNEX B. BENIN DEPOT AND HEALTH FACILITY SPECIFICATIONS

Facility Name	storage size (m2)	Distance to main road (km)	Supplier	Distance to supply facility (km)
DRZ Natitingou	328	-	CAME Cotonou	1
CS Cotonou 6	177	-	DRZ Cotonou 6	1
HZ Menontin	0	0.3	DRZ Cotonou 5	3
CS Houénoussou	34	-	DRZ Cotonou 6	7
DRZ Ouidah	317	2.0	CAME Cotonou	40
HZ Calavi	80	1.0	DRZ Abomey-Calavi-So-ava	18
CS Toucountouna	35	-	DRZ Natitingou	25
CS Natitingou	0	0.5	DRZ Natitingou	1
CS Boukombé	52	45.0	DRZ Natitingou	30
CS Tourou	31	0.3	DRZ Parakou-N'Dali	15
CS Kpebié	27	0.2	DRZ Parakou-N'Dali	2
CS Zongo II	90	0.2	DRZ Parakou-N'Dali	5
HZ Natitingou	101	0.1	DRZ Natitingou	1
DRZ Cotonou 6	168	1.0	CAME Cotonou	5
CS Parakou	0	0.5	DRZ Parakou-N'Dali	4
CS N'dali	89	1.0	DRZ Parakou-N'Dali	60
HZ St Jean de Dieu de Boko	0	0.2	CAME Parakou	15
DRZ Cotonou 2&3	335	4.0	CAME Cotonou	5
H Conf Ste Bakhita Natitingou	45	3.0	CAME Natitingou	4
DRZ Tchaourou	200	0.5	CAME Parakou	55
CS Zogbo	0	-	DRZ Parakou-N'Dali	5
DRZ Parakou-N'Dali	0	-	CAME Parakou	3

ANNEX C. BENIN ANNUAL UTILITY COST OF EACH DEPOT AND HEALTH FACILITY TO STORE COMMODITIES

Note: Data from the surveys are documented in this table. Boxes shaded with pale red signify missing data. Missing information was estimated using a heuristic based on data available from similar facilities in similar locations. The research team used three assumptions to focus on specific costs associated with each facility's storage capabilities: (1) 10% of hospital utilities are allocated to stock, (2) 50% of health center and dispensary utilities are allocated to stock, and (3) 100% of depot utilities allocated to stock.

Facility Name	Monthly Cost (CFA)				Annual Cost			
	Water	Electricity	Communication	Fuel, Paraffin, Gas	Annual Cost of Utilities (CFA)	Cost Attributed to Stock Room (CFA)	Annual Cost of Utilities (USD)	Cost Attributed to Stock Room (USD)
DRZ Natitingou			36,875	300,000	4,042,500	2,021,250	\$ 8,181.36	\$ 4,090.68
CS Tourou			10,000		120,000	120,000	\$ 242.86	\$ 242.86
HZ Menontin	533,371	567,575	113,334	1,257,200	29,657,754	2,965,775	\$ 60,022.45	\$ 6,002.25
CS Toucountouna			16,875		202,500	202,500	\$ 409.83	\$ 409.83
DRZ Ouidah			36,875	125,000	1,942,500	971,250	\$ 3,931.30	\$ 1,965.65
HZ Calavi	1,181,778	567,575	166,000	1,500,000	40,984,240	4,098,424	\$ 82,945.41	\$ 8,294.54
CS Cotonou 6			20,000	7,000	324,000	324,000	\$ 655.72	\$ 655.72
CS Kpebié			10,000		120,000	120,000	\$ 242.86	\$ 242.86
CS Zongo II			10,000		120,000	120,000	\$ 242.86	\$ 242.86
CS Parakou			25,000		300,000	300,000	\$ 607.15	\$ 607.15
CS N'dali			40,000	35,000	900,000	900,000	\$ 1,821.45	\$ 1,821.45
CS Zogbo		200,000	15,556		2,586,667	2,586,667	\$ 5,234.99	\$ 5,234.99
HZ Natitingou	408,334	458,333	283,334	1,856,075	36,072,912	3,607,291	\$ 73,005.68	\$ 7,300.57
DRZ Cotonou 6			16,250	25,000	495,000	247,500	\$ 1,001.80	\$ 500.90
CS Natitingou	10,000	200,000	10,000		2,640,000	2,640,000	\$ 5,342.93	\$ 5,342.93
CS Boukombé		200,000	10,000		2,520,000	2,520,000	\$ 5,100.07	\$ 5,100.07
HZ St Jean de Dieu de Boko		1,044,393	2,000	177,460	14,686,236	1,468,624	\$ 29,722.54	\$ 2,972.25
DRZ Cotonou 2&3			57,500	50,000	1,290,000	645,000	\$ 2,610.75	\$ 1,305.37
H Conf Ste Bakhita Natitingou	10,000	200,000	2,000	6,250	2,619,000	261,900	\$ 5,300.43	\$ 530.04
DRZ Tchaurou			5,000		60,000	30,000	\$ 121.43	\$ 60.72
CS Houénoussou			15,556		186,667	186,667	\$ 377.78	\$ 377.78
DRZ Parakou-N'Dali			36,875		442,500	221,250	\$ 895.55	\$ 447.77

ANNEX D. BENIN ANNUAL LABOR COST CALCULATION OF EACH DEPOT AND HEALTH FACILITY TO STORE AND DISTRIBUTE COMMODITIES

Note: Boxes shaded with pale red signify missing data. Missing information was estimated using a heuristic based on data available from other facilities with staff holding the same title and in a similar location. Salary dedicated to stock was calculated by multiplying the annual salary of an individual with that person's expected dedication to stock.

Facility Name	#	Staff Title	Annual Salary (CFA)	Dedication to stock	Annual Labor Costs (CFA)	Annual Labor Costs (USD)
DRZ Natitingou	1	Gestionnaire de dépôt répartiteur	1,820,616	100%	1,820,616	3,684.63
DRZ Natitingou	1	Magasinier	660,000	100%	660,000	1,335.73
CS Tourou	1	nurse	1,347,000	25%	336,750	681.53
CS Tourou	2	Commis de pharmacie	798,024	50%	399,012	807.54
CS Tourou	1	Membres du COGECS	180,000		720,000	1,457.16
HZ Menotin	1	Magasinier	1,548,000	100%	1,548,000	3,132.90
HZ Menotin	1	Responsable approvisionnement	2,179,069	100%	2,179,069	4,410.08
CS Toucountouna	1	Dispensateur	660,000	60%	396,000	801.44
CS Toucountouna	1	Gestion Comptable	864,000	40%	345,600	699.44
DRZ Ouidah	1	Gestionnaire de dépôt répartiteur	1,390,431	100%	1,390,431	2,814.00
HZ Calavi	1	nurse	5,425,872	25%	1,356,468	2,745.27
HZ Calavi	1	Aides soignants	1,249,884	25%	312,471	632.39
CS Cotonou 6	1	Gestionnaire de dépôt répartiteur	1,128,337	100%	1,128,337	2,283.57
CS Cotonou 6	1	Magasinier	391,752	100%	391,752	792.84
CS Kpebié	1	nurse	1,405,281	30%	421,584	853.22
CS Kpebié	1	Commis de pharmacie	1,296,000	80%	1,036,800	2,098.31
CS Kpebié	1	Membres du COGECS	180,000		1,080,000	2,185.74
CS Zongo II	1	nurse	1,047,258	30%	314,177	635.84
CS Zongo II	2	Commis de pharmacie	750,000	80%	600,000	1,214.30
CS Zongo II	3	Membres du COGECS	180,000		900,000	1,821.45
CS Parakou	1	Comptable	897,384	25%	224,346	454.04
CS N'dali	1	Comptable	897,384	25%	224,346	454.04
CS Zogbo	1	nurse	1,200,000	10%	120,000	242.86
HZ Natitingou	1	Magasinier	1,594,005	100%	1,594,005	3,226.01
DRZ Cotonou 6	1	Gestionnaire de dépôt répartiteur et comptable de zone	1,183,200	100%	1,183,200	2,394.60
DRZ Cotonou 6	1	Technicienne d'Hygiène et d'Assainissement(THA) converti en magasinier	1,183,200	100%	1,183,200	2,394.60
CS Natitingou	3	Dispensateur	789,000	100%	789,000	1,596.81
CS Natitingou	1	Comptable	834,000	25%	208,500	421.97
CS Boukombé	1	Comptable et son comis	804,000	10%	80,400	162.72
HZ St Jean de Dieu de Boko	1	Magasinier	1,054,946	100%	1,054,946	2,135.04
DRZ Cotonou 2&3	1	Gestionnaire de dépôt répartiteur	1,092,000	100%	1,092,000	2,210.03
H Conf Ste Bakhita Natitingou	1	Magasinier	420,000	100%	420,000	850.01
H Conf Ste Bakhita Natitingou	1	Surveillante générale	996,000	100%	996,000	2,015.74
DRZ Tchaurou	1	Gestionnaire de dépôt répartiteur	1,728,000	100%	1,728,000	3,497.19
CS Houénoussou	1	Responsable de pharmacie de gros et détails	540,000	100%	540,000	1,092.87
CS Houénoussou	1	Dispensateur	408,000	100%	408,000	825.73
DRZ Parakou-Ndali	1	Gestionnaire de dépôt répartiteur	1,183,200	100%	1,183,200	2,394.60

ANNEX E. BENIN ANNUAL SECURITY COST OF EACH DEPOT AND HEALTH FACILITY TO STORE COMMODITIES

Note: Data from the surveys is documented in this table. Boxes shaded with pale red signify missing data. Missing information was estimated using a heuristic based on the average cost for a similar facility type. The research team used two assumptions to focus on specific costs associated with each facility's storage capabilities: (1) 10% of hospital security costs are allocated to stock and (2) 50% of health center and depot security costs are allocated to stock (depots are usually situated within a health center or hospital compound and use that facility's guard).

Facility Name	Security	Guards	Monthly Cost (CFA)	Annual Cost (CFA)	Cost Attributed to Stock (CFA)	Cost Attributed to Stock (USD)
DRZ Natitingou	No		-	-	-	\$ -
CS Tourou	Yes		31,000	372,000	37,200	\$ 75.29
HZ Menontin	Yes	Frais de gardiennage	335,000	4,020,000	2,010,000	\$ 4,067.91
CS Toucountouna	No			-	-	\$ -
DRZ Ouidah	Yes	Agents de sécurité	31,650	379,800	189,900	\$ 384.33
HZ Calavi	Yes	Contrat	300,000	3,600,000	1,800,000	\$ 3,642.91
CS Cotonou 6	No			-	-	\$ -
CS Kpebié	Yes		44,560	534,720	53,472	\$ 108.22
CS Zongo II	Yes		32,000	384,000	38,400	\$ 77.72
CS Parakou	Yes		35,000	420,000	42,000	\$ 85.00
CS N'dali	Yes	Agents de sécurité	63,250	759,000	75,900	\$ 153.61
CS Zogbo	Yes		49,000	588,000	58,800	\$ 119.00
HZ Natitingou	Yes		145,000	1,740,000	870,000	\$ 1,760.74
DRZ Cotonou 6	Yes		49,000	588,000	294,000	\$ 595.01
CS Natitingou	Yes		15,000	180,000	18,000	\$ 36.43
CS Boukombé	Yes		49,000	588,000	58,800	\$ 119.00
HZ St Jean de Dieu de Boko	Yes	Agents de sécurité	100,355	1,204,260	120,426	\$ 243.72
DRZ Cotonou 2&3	No			-	-	\$ -
H Conf Ste Bakhita Natitingou	Yes		33,500	402,000	40,200	\$ 81.36
DRZ Tchaourou	Yes	Guardes	31,625	379,500	189,750	\$ 384.02
CS Houénoussou	Yes	Contrat	150,000	1,800,000	180,000	\$ 364.29
DRZ Parakou-N'Dali	Yes		31,625	379,500	189,750	\$ 384.02

ANNEX F. BENIN ANNUAL TRANSPORTATION COST OF EACH DEPOT AND HEALTH FACILITY TO RETRIEVE COMMODITIES

Note: Data from the surveys are documented in this table. Boxes shaded with pale red signify missing data. Missing information was estimated using a heuristic based facility type and distance to resupply location. Cases in which zero cost is allocated to a health facility are those situations where the facility is located on the same compound as the depot.

			Driver				Transport Costs per Trip		Annual Transport Costs			Total	
Facility Name	Trips/Month to Retrieve Stock	Distance to supply facility (km)	Number of Full Time Drivers	Annual Salary (CFA)	Annual Training Costs (CFA)	Annual Communication Costs (CFA)	Courier: Cost per Trip (CFA)	Fuel Costs for Round Trip to Supply Facility (CFA)	Annual Maintenance (CFA)	Annual Insurance (CFA)	Depreciated Value (CFA)	Total Cost Attributed to Stock (CFA)	Total Cost Attributed to Stock (USD)
DRZ Natitingou	1.0	-	1	506,616		60,000		-	150,000	80,000	-	41,927	\$ 84.85
CS Tourou	1.0	15					30,000	-			-	360,000	\$ 728.58
HZ Menontin	1.0	3	1	544,180			20,000	-			-	268,641	\$ 543.69
CS Toucountouna	0.5	25	2	403,800		24,000	2,500	2,700		80,000	160,000	48,774	\$ 98.71
DRZ Ouidah	1.0	40					35,000	-			-	420,000	\$ 850.01
HZ Calavi	1.0	18	4	564,000	100,000	60,000		10,000	38,500		3,500,000	344,342	\$ 696.89
CS Cotonou 6	1.0	-						-			-	-	\$ -
CS Kpebié	1.0	2					2,000	-			-	24,000	\$ 48.57
CS Zongo II	1.0	5					10,000	-			-	120,000	\$ 242.86
CS Parakou	1.0	4					5,000	-			-	60,000	\$ 121.43
CS N'dali	1.0	60	2	444,000		60,000		6,480		-	3,500,000	288,497	\$ 583.87
CS Zogbo	1.0	5						-			-	168,000	\$ 340.00
HZ Natitingou	1.0	-	1	384,000	60,000			-	70,000		3,500,000	211,263	\$ 427.56
DRZ Cotonou 6	1.0	5						-			-	51,178	\$ 103.58
CS Natitingou	1.0	-						-			-	-	\$ -
CS Boukombé	1.0	30	1	600,000	10,000			10,000	70,000	-	3,500,000	340,000	\$ 688.10
HZ St Jean de Dieu de Boko	1.0	15	3	583,301		24,000		1,350	98,300	50,000	-	55,968	\$ 113.27
DRZ Cotonou 2&3	1.0	5	2	672,180	50,000			900	45,000		-	51,178	\$ 103.58
H Conf Ste Bakhita Natitingou	1.0	4	1	672,000				-	10,000		-	35,895	\$ 72.65
DRZ Tchaourou	0.5	30	1	511,716		24,000		3,394	47,500	47,500	3,500,000	129,069	\$ 261.21
CS Houénoussou	1.0	7					14,000	-			-	168,000	\$ 340.00
DRZ Parakou- N'Dali	1.0	3						-			-	60,000	\$ 121.43

ANNEX G. BENIN ANNUAL IT COST AT EACH DEPOT AND HEALTH FACILITY TO STORE COMMODITIES

Note: Data from the surveys are documented in this table. Boxes shaded with pale red signify missing data. Missing information was estimated using an average of the costs incurred by HZ Calavi and CS Natitingou. The research team assumed a two-year straight-line depreciation.

Facility Name	Computer	Software	Initial Cost (CFA)	Depreciated Value (CFA)	Depreciated Value (USD)
DRZ Natitingou	Yes	Medistock	2,200,000	1,100,000	\$ 2,226.22
CS Tourou	No			-	\$ -
HZ Menontin	Yes	Medistock	2,200,000	1,100,000	\$ 2,226.22
CS Toucountouna	No			-	\$ -
DRZ Ouidah	Yes	Medistock	2,200,000	1,100,000	\$ 2,226.22
HZ Calavi	Yes	Medistock	2,400,000	1,200,000	\$ 2,428.60
CS Cotonou 6	Yes	Medistock	2,200,000	1,100,000	\$ 2,226.22
CS Kpebié	No			-	\$ -
CS Zongo II	No			-	\$ -
CS Parakou	No			-	\$ -
CS N'dali	No			-	\$ -
CS Zogbo	No			-	\$ -
HZ Natitingou	Yes	Medistock	2,200,000	1,100,000	\$ 2,226.22
DRZ Cotonou 6	Yes	Medistock	2,200,000	1,100,000	\$ 2,226.22
CS Natitingou	Yes	Medistock	2,000,000	1,000,000	\$ 2,023.84
CS Boukombé	No			-	\$ -
HZ St Jean de Dieu de Boko	Yes	Medistock	750,000	375,000	\$ 758.94
DRZ Cotonou 2&3	Yes	Medistock	2,200,000	1,100,000	\$ 2,226.22
H Conf Ste Bakhita Natitingou	No			-	\$ -
DRZ Tchaourou	Yes	Medistock	2,200,000	1,100,000	\$ 2,226.22
CS Houénoussou	No			-	\$ -
DRZ Parakou-N'Dali	Yes	Medistock	2,200,000	1,100,000	\$ 2,226.22

ANNEX H. BENIN ANNUAL EQUIPMENT COST OF EACH DEPOT AND HEALTH FACILITY TO STORE COMMODITIES

Note: Equipment considered in this analysis includes shelves, carts, fans, pallets, A/C units, and ladders. When the initial cost of these items was unavailable, an average of those available costs was used. The research team assumed a five-year straight-line depreciation.

Facility Name	Total Equipment			
	Total Cost <i>not depreciated</i> (CFA)	Total Cost <i>not depreciated</i> (USD)	Depreciated Value (CFA)	Depreciated Value (USD)
DRZ Natitingou	518,000.00	\$ 1,048.35	103,600.00	\$ 209.67
CS Tourou	160,000.00	\$ 323.81	32,000.00	\$ 64.76
HZ Menontin	25,000.00	\$ 50.60	5,000.00	\$ 10.12
CS Toucountouna	-	\$ -	-	\$ -
DRZ Ouidah	458,000.00	\$ 926.92	91,600.00	\$ 185.38
HZ Calavi	928,000.00	\$ 1,878.12	185,600.00	\$ 375.62
CS Cotonou 6	314,000.00	\$ 635.48	62,800.00	\$ 127.10
CS Kpebié	25,000.00	\$ 50.60	5,000.00	\$ 10.12
CS Zongo II	34,000.00	\$ 68.81	6,800.00	\$ 13.76
CS Parakou	-	\$ -	-	\$ -
CS N'dali	-	\$ -	-	\$ -
CS Zogbo	-	\$ -	-	\$ -
HZ Natitingou	10,000.00	\$ 20.24	2,000.00	\$ 4.05
DRZ Cotonou 6	243,000.00	\$ 491.79	48,600.00	\$ 98.36
CS Natitingou	-	\$ -	-	\$ -
CS Boukombé	-	\$ -	-	\$ -
HZ St Jean de Dieu de Boko	-	\$ -	-	\$ -
DRZ Cotonou 2&3	367,000.00	\$ 742.75	73,400.00	\$ 148.55
H Conf Ste Bakhita Natitingou	370,000.00	\$ 748.82	74,000.00	\$ 149.76
DRZ Tchaourou	545,000.00	\$ 1,102.99	109,000.00	\$ 220.60
CS Houénoussou	25,000.00	\$ 50.60	5,000.00	\$ 10.12
DRZ Parakou-N'Dali	-	\$ -	-	\$ -

ANNEX I. BENIN ANNUAL WAREHOUSE COST OF EACH DEPOT AND HEALTH FACILITY TO STORE COMMODITIES

Note: To calculate depreciation of a warehouse, a 30-year straight-line depreciation was applied. The year in which the facility was built was collected during interviews. Some facilities provided the initial cost of construction. Boxes shaded with pale red signify missing data. Missing information was estimated using a heuristic based on facility type. The research team used three assumptions to focus on specific costs associated with each facility's storage capabilities: (1) 10% of hospital warehouse depreciation costs are allocated to stock, (2) 50% of health center and dispensary warehouse depreciation costs are allocated to stock, and (3) 100% of depot depreciation costs are allocated to stock.

Facility Name	Size - Storage + Dispensary (m2)	Size - Entire Facility (m2)	Year Built	Initial Cost (CFA)	Depreciation (CFA)	Depreciation attributed to stock (CFA)	Depreciation attributed to stock (USD)
DRZ Natitingou	328	329	2008	15,000,000.00	500,000.00	500,000.00	\$ 1,011.92
CS Tourou	31	30,000	2001	15,000,000.00	500,000.00	250,000.00	\$ 505.96
HZ Menontin					-	-	\$ -
CS Toucountouna	35	76,200			-	-	\$ -
DRZ Ouidah	317				-	-	\$ -
HZ Calavi	80	2,409	2003	17,000,000.00	566,666.67	56,666.67	\$ 114.68
CS Cotonou 6	177		2013	15,000,000.00	500,000.00	250,000.00	\$ 505.96
CS Kpebié	27		2001	15,000,000.00	500,000.00	250,000.00	\$ 505.96
CS Zongo II	90		1997	15,000,000.00	500,000.00	250,000.00	\$ 505.96
CS Parakou					-	-	\$ -
CS N'dali	89		2002	15,000,000.00	500,000.00	250,000.00	\$ 505.96
CS Zogbo					-	-	\$ -
HZ Natitingou	101		1949		-	-	\$ -
DRZ Cotonou 6	168		2013	15,000,000.00	500,000.00	500,000.00	\$ 1,011.92
CS Natitingou	0	20,000	1980		-	-	\$ -
CS Boukombé	52	618	1980		-	-	\$ -
HZ St Jean de Dieu de Boko			2005	17,000,000.00	566,666.67	56,666.67	\$ 114.68
DRZ Cotonou 2&3	335	1,700			-	-	\$ -
H Conf Ste Bakhita Natitingou	45				-	-	\$ -
DRZ Tchaourou	200	50,040		15,000,000.00	500,000.00	500,000.00	\$ 1,011.92
CS Houénoussou	34	683	1994	15,000,000.00	500,000.00	250,000.00	\$ 505.96
DRZ Parakou-N'Dali					-	-	\$ -

ANNEX J. KENYA SAMPLE SITES

The following table lists the health facilities visited in Kenya. Each color represents a province (e.g., Nairobi). The various tones highlight the facility type, from the darkest tone which represents the central and regional warehouses to the lightest tone which represents health centers.

Type	Province	District	Facility Name
CMS	NAIROBI	NAIROBI	CMS
DISTRICT HOSPITAL	NAIROBI	NAIROBI	MBAGATHI DISTRICT HOSPITAL
HEALTH CENTER	NAIROBI	NAIROBI	NGAIRA HEALTH CENTER
HEALTH CENTER	NAIROBI	NAIROBI	STC CASINO HEALTH CENTER
HEALTH CENTER	NAIROBI	NAIROBI	BAHATI HEALTH CENTER
HEALTH CENTER	NAIROBI	NAIROBI	LANGATA HEALTH CENTER
HEALTH CENTER	NAIROBI	NAIROBI	MAKADARA HEALTH CENTER
REGIONAL STORE	NYANZA	KISUMU	REGIONAL STORE
DISTRICT HOSPITAL	NYANZA	HOMA BAY	HOMA BAY DISTRICT HOSPITAL
DISTRICT HOSPITAL	NYANZA	SUBA	MBITA DISTRICT HOSPITAL
HEALTH CENTER	NYANZA	SUBA	KITARE HEALTH CENTER (CHW LINK FACILITY)
DISPENSARY	NYANZA	HOMA BAY	MINIAMBO DISPENSARY
DISPENSARY	NYANZA	HOMA BAY	RARIW DISPENSARY
HEALTH CENTER	NYANZA	HOMA BAY	MAKONGENI HEALTH CENTER (CHW LINK FACILITY)
DISPENSARY	NYANZA	SUBA	Usao DISPENSARY
HEALTH CENTER	NYANZA	SUBA	TOM MBOYA HEALTH CENTER (MBITA) (CHW LINK FACILITY)
DISPENSARY	NYANZA	HOMA BAY	LAMBWE DISPENSARY
HEALTH CENTER	NYANZA	HOMA BAY	RANGWE SUB-DISTRICT HOSPITAL (CHW LINK FACILITY)
REGIONAL STORE	COAST	MOMBASA	REGIONAL STORE
DISTRICT HOSPITAL	COAST	MOMBASA	PORT REITZ DISTRICT HOSPITAL
DISTRICT HOSPITAL	COAST	MOMBASA	TUDOR DISTRICT HOSPITAL
DISPENSARY	COAST	MOMBASA	MAWENI CDF DISPENSARY
HEALTH CENTER	COAST	MOMBASA	MIRITINI CDR DISPENSARY
HEALTH CENTER	COAST	MOMBASA	MLALEO HEALTH CENTER
HEALTH CENTER	COAST	MOMBASA	SHIMO ANNEX HEALTH CENTER

ANNEX K. KENYA HOSPITAL AND PHC SPECIFICATIONS

Facility Name	Storage Size (m2)	Distance to Main Road (km)	Distance to Supply Facility (km)
Rangwe Sub District Hospital	70	5.0	500
Mbita district hospital	123	0.3	430
Port Reitz District Hospital	267	5.0	500
Homa Bay District Hospital	300	2.0	500
Mbagathi district hospital	4000	0.5	30
Tudor district hospital	36	2.0	500
Makongeni Health Centre	48	0.5	500
Miritini CDF Dispensary	73	1.0	500
Lambwe Health Dispensary	44	5.0	500
Usao health centre	56	5.0	600
Mlaleo Health Centre	254	2.5	500
Makadara Health Centre	373	5.0	5
Miniambo Dispensary	9	0.1	500
Bahati Health Centre	153	1.0	5
Ngaira dispensary	73	0.5	5
STC Casino Health Centre	37	0.5	15
Maweni Dispensary	25	5.0	500
Shimo La Tewa Annex Dispensary	15	2.5	500
Langata health center	80	0.1	15
Tom Mboya Health Centre	122	10.0	500
Kitare health centre	83	2.0	500
Rariw Dispensary	54	18.0	500

ANNEX L. KENYA ANNUAL UTILITY COST OF EACH HEALTH FACILITY TO STORE COMMODITIES

Note: Data from the surveys are documented in this table. Boxes shaded with pale red signify missing data. Missing information was replaced using data from other facilities in a similar location. The research team used two assumptions to focus on specific costs associated with each facility's storage capabilities: (1) 10% of hospital utilities are allocated to stock and (2) 50% of health center and dispensary utilities are allocated to stock.

Facility Name	Monthly Costs (KSh)				Annual Costs			
	Water	Electricity	Communications	Fuel, Paraffin, Gas	Cost of Utilities (KSh)	Cost attributed to stock room (KSh)	Cost of Utilities (USD)	Cost attributed to stock room (USD)
Rangwe Sub District Hospital	3,000.00	3,000.00		6,000.00	600.00	70.79	\$ 7.08	\$ 0.84
Mbita District Hospital	25,000.00	8,750.00		43,750.00	4,375.00	516.16	\$ 51.62	\$ 6.09
Port Reitz District Hospital	480,000.00	1,000.00		541,000.00	54,100.00	6,382.73	\$ 638.27	\$ 75.30
Homa Bay District Hospital	300,000.00	35,000.00		495,000.00	49,500.00	5,840.02	\$ 584.00	\$ 68.90
Mbagathi District Hospital	540,000.00	189,000.00		979,000.00	97,900.00	11,550.26	\$ 1,155.03	\$ 136.27
Tudor District Hospital	30,000.00	17,750.00		67,750.00	6,775.00	799.32	\$ 79.93	\$ 9.43
Makongeni Health Centre		400.00		1,200.00	600.00	14.16	\$ 7.08	\$ 0.17
Miritini CDF Dispensary	6,500.00	1,000.00		11,000.00	5,500.00	129.78	\$ 64.89	\$ 1.53
Lambwe Health Dispensary		2,000.00	4,480.00	6,480.00	3,240.00	76.45	\$ 38.23	\$ 0.90
Usao Health Centre	2,000.00	500.00	11,500.00	16,000.00	8,000.00	188.77	\$ 94.38	\$ 2.23
Mlaleo Health Centre	7,000.00	3,000.00	4,000.00	14,000.00	7,000.00	165.17	\$ 82.59	\$ 1.95
Makadara Health Centre	6,000.00		11,500.00	22,300.00	11,150.00	263.10	\$ 131.55	\$ 3.10
Miniambo Dispensary	6,000.00			10,800.00	5,400.00	127.42	\$ 63.71	\$ 1.50
Bahati Health Centre	6,000.00	375.00	11,500.00	22,675.00	11,337.50	267.52	\$ 133.76	\$ 3.16
Ngaira Dispensary	6,000.00	2,000.00		12,800.00	6,400.00	151.01	\$ 75.51	\$ 1.78
STC Casino Health Centre	6,000.00	3,000.00		13,800.00	6,900.00	162.81	\$ 81.41	\$ 1.92
Maweni Dispensary		1,000.00		5,000.00	2,500.00	58.99	\$ 29.50	\$ 0.70
Shimo La Tewa Annex	6,500.00	2,000.00	4,500.00	16,500.00	8,250.00	194.67	\$ 97.33	\$ 2.30
Langata Health Center	6,000.00	1,500.00		12,300.00	6,150.00	145.12	\$ 72.56	\$ 1.71
Tom Mboya Health Centre	8,000.00	1,000.00		14,600.00	7,300.00	172.25	\$ 86.13	\$ 2.03
Kitare Health Centre	5,000.00	2,000.00	1,000.00	24,000.00	12,000.00	283.15	\$ 141.58	\$ 3.34
Rariw Dispensary		1,000.00		1,000.00	500.00	11.80	\$ 5.90	\$ 0.14

ANNEX M. KENYA ANNUAL LABOR COST CALCULATION OF EACH HEALTH FACILITY TO STORE AND DISTRIBUTE COMMODITIES

Note: Boxes shaded with pale red signify missing data. These costs were estimated using data from other facilities with employees who have the same title in a similar region. Salary dedicated to stock was calculated by multiplying the annual salary of an individual with that persons expected dedication to stock.

Facility Name	#	Staff Title	Annual Salary (KSh)	Dedication to stock	Annual Labor Costs (KSh)	Annual Labor Costs (USD)
Rangwe Sub District Hospital	1	Pharmacy technician	576,000.00	80%	460,800.00	5,436.83
Mbita District Hospital	1	District pharmacist	1,700,000.00	39%	663,000.00	7,822.53
Mbita District Hospital	1	Deputy pharmacist	1,500,000.00	29%	435,000.00	5,132.43
Mbita District Hospital	1	Pharmacy technician - government employee	168,000.00	100%	168,000.00	1,982.18
Mbita District Hospital	1	Pharmacy technicians - partner employee	540,000.00	100%	540,000.00	6,371.29
Port Reitz District Hospital	1	Pharmacist	420,000.00	13%	52,500.00	619.43
Port Reitz District Hospital	3	Pharmacy technician	648,000.00	80%	518,400.00	6,116.44
Port Reitz District Hospital	3	Stock manager	540,000.00	100%	540,000.00	6,371.29
Homa Bay District Hospital	1	Store keeper	216,000.00	100%	216,000.00	2,548.52
Homa Bay District Hospital	1	Stock manager	144,000.00	100%	144,000.00	1,699.01
Homa Bay District Hospital	1	Pharmacy technician	420,000.00	90%	378,000.00	4,459.90
Mbagathi District Hospital	1	Pharmacy technician	1,200,000.00	80%	960,000.00	11,326.74
Tudor District Hospital	2	Pharmacy technician	511,944.00	90%	460,749.60	5,436.24
Makongeni Health Centre	2	Nurse	504,000.00	80%	403,200.00	4,757.23
Miritini CDF Dispensary	1	Nurse in charge	558,000.00	13%	69,750.00	822.96
Miritini CDF Dispensary	1	CHW	60,000.00	60%	36,000.00	424.75
Lambwe Health Dispensary	1	Clinical Officer	576,000.00	3%	14,400.00	169.90
Lambwe Health Dispensary	1	Nurse	240,000.00	100%	240,000.00	2,831.68
Usao Health Centre	1	Nurse in charge	672,000.00	14%	94,080.00	1,110.02
Usao Health Centre	1	Nurse	672,000.00	100%	672,000.00	7,928.72
Usao Health Centre	1	Nurse	672,000.00	100%	672,000.00	7,928.72
Mlaleo Health Centre	1	Pharmacy technician	295,944.00	100%	295,944.00	3,491.75
Mlaleo Health Centre		Casual labor	540,000.00	100%	540,000.00	6,371.29
Makadara Health Centre	1	CHEW (acts as pharmacist)	630,000.00	40%	252,000.00	2,973.27
Makadara Health Centre	1	Nurse	528,000.00	100%	528,000.00	6,229.71
Makadara Health Centre	1	Nurse in charge	1,020,000.00	6%	63,750.00	752.17
Miniambo Dispensary	1	Nurse	276,000.00	80%	220,800.00	2,605.15
Bahati Health Centre	1	Nurse in charge	1,020,000.00	30%	306,000.00	3,610.40
Bahati Health Centre	1	Deputy in charge	1,020,000.00	25%	255,000.00	3,008.66
Bahati Health Centre	2	Nurse	720,000.00	100%	720,000.00	8,495.05
Bahati Health Centre	1	Nurse - Maternal and Child Health	912,000.00	6%	57,000.00	672.53
Ngaira Dispensary	1	Nurse in charge	600,000.00	40%	240,000.00	2,831.68
Ngaira Dispensary	1	Nurse	690,000.00	100%	690,000.00	8,141.09
STC Casino Health Centre	2	Pharmacy technician	540,000.00	100%	540,000.00	6,371.29
STC Casino Health Centre	10	Nurse	690,000.00	100%	690,000.00	8,141.09
STC Casino Health Centre	1	District pharmacist	1,200,000.00	5%	60,000.00	707.92
STC Casino Health Centre	1	Nurse in charge	948,000.00	40%	379,200.00	4,474.06
Maweni Dispensary	1	Pharmacy technician	255,648.00	100%	255,648.00	3,016.31
Maweni Dispensary	1	Nurse in charge	948,000.00	15%	142,200.00	1,677.77
Shimo La Tewa Annex Dispensary	1	Clinician in charge	648,000.00	3%	16,200.00	191.14
Shimo La Tewa Annex Dispensary	1	Pharmacy technician	252,000.00	100%	252,000.00	2,973.27
Shimo La Tewa Annex Dispensary	1	Nurse in charge	840,000.00	50%	420,000.00	4,955.45
Shimo La Tewa Annex Dispensary	1	Casual employee	72,000.00	100%	72,000.00	849.51
Langata Health Center	1	Pharmacy technician	300,000.00	80%	240,000.00	2,831.68
Langata Health Center	2	Laboratory technician	700,000.00	80%	560,000.00	6,607.26
Tom Mboya Health Centre	1	Pharmacy technician	240,000.00	100%	240,000.00	2,831.68
Tom Mboya Health Centre	2	Casual employee	36,000.00	100%	36,000.00	424.75
Tom Mboya Health Centre	1	Nurse	330,000.00	100%	330,000.00	3,893.57
Kitare Health Centre	1	clinical nurse/registered clinical officer	576,000.00	14%	80,640.00	951.45
Kitare Health Centre	1	nurse	606,000.00	100%	606,000.00	7,150.00
Rariw Dispensary	1	Clerk	540,000.00	80%	432,000.00	5,097.03

ANNEX N. KENYA ANNUAL SECURITY COST OF EACH HEALTH FACILITY TO STORE COMMODITIES

Note: Data from the surveys are documented in this table. Boxes shaded with pale red signify missing data. Missing information was replaced using data from other facilities reporting either urban, semirural, or rural settings. The research team used two assumptions to focus on specific costs associated with each facility's storage capabilities: (1) 10% of hospital security costs are allocated to stock and (2) 50% of health center and dispensary security costs are allocated to stock.

Facility Name	#	Guards	Cost: Guard/ Month (KSh)	Cost: Total Facility (KSh)	Cost Attributed to Stock (KSh)	Cost Attributed to Stock (USD)
Rangwe Sub District Hospital	4	Night and day guard	7,500.00	360,000.00	36,000.00	\$ 424.73
Mbita District Hospital	5	Contracted guard	6,500.00	390,000.00	39,000.00	\$ 460.12
Port Reitz District Hospital		Contracted guard		1,296,000.00	129,600.00	\$ 1,529.02
Homa Bay District Hospital		Contracted security firm		780,000.00	78,000.00	\$ 920.25
Mbagathi District Hospital				1,134,000.00	113,400.00	\$ 1,337.90
Tudor District Hospital				1,134,000.00	113,400.00	\$ 1,337.90
Makongeni Health Centre	1	Guard	1,000.00	12,000.00	6,000.00	\$ 70.79
Miritini CDF Dispensary	1	Contracted guard	5,000.00	60,000.00	30,000.00	\$ 353.94
Lambwe Health Dispensary	2	Security staff	3,000.00	72,000.00	36,000.00	\$ 424.73
Usao Health Centre	2	Security staff	3,000.00	72,000.00	36,000.00	\$ 424.73
Mlaleo Health Centre		Guard	4,500.00	54,000.00	27,000.00	\$ 318.55
Makadara Health Centre	3	Guard	11,333.33	408,000.00	204,000.00	\$ 2,406.80
Miniambo Dispensary	1	Night guard	3,000.00	36,000.00	18,000.00	\$ 212.36
Bahati Health Centre	4	Guard	11,333.00	543,984.00	271,992.00	\$ 3,208.97
Ngaira Dispensary	9	Guard	11,333.00	1,223,964.00	611,982.00	\$ 7,220.17
STC Casino Health Centre	3	Guard	15,000.00	540,000.00	270,000.00	\$ 3,185.46
Maweni Dispensary			5,000.00	60,000.00	30,000.00	\$ 353.94
Shimo La Tewa Annex Dispensary	1		5,000.00	60,000.00	30,000.00	\$ 353.94
Langata Health Center	2	Guard	15,000.00	360,000.00	180,000.00	\$ 2,123.64
Tom Mboya Health Centre	2	Contracted guard	3,000.00	72,000.00	36,000.00	\$ 424.73
Kitare Health Centre	2	Security staff	3,600.00	86,400.00	43,200.00	\$ 509.67
Rariw Dispensary	2	Night and day guard	3,000.00	72,000.00	36,000.00	\$ 424.73

ANNEX O. KENYA ANNUAL IT COST OF EACH HEALTH FACILITY TO STORE COMMODITIES

Note: Boxes shaded with pale red signify missing data. These costs were estimated using data available. A two-year straight-line depreciation was applied based on data available from two hospitals. IT costs at health facilities were not considered because few had computers, and of those facilities that did, the computers were not used for inventory activities.

Facility Name	Software	Updates	Maintenance (KSh)	Maintenance (USD)	Initial Cost (KSh)	Depreciated Value (KSh)	Depreciated Value (USD)
Rangwe Sub District Hospital	ITT and ADT	4/year	8,000.00	\$ 94.38	180,000.00	90,000.00	\$ 1,061.82
Mbita District Hospital	ITT	2/week	2,000.00	\$ 23.60	180,000.00	90,000.00	\$ 1,061.82
Port Reitz District Hospital	IQ care, Afya IT		-	\$ -	180,000.00	90,000.00	\$ 1,061.82
Homa Bay District Hospital	Inventory tracking tool		2,000.00	\$ 23.60	180,000.00	90,000.00	\$ 1,061.82
Mbagathi District Hospital	Mbagathi tool		2,000.00	\$ 23.60	180,000.00	90,000.00	\$ 1,061.82
Tudor District Hospital			2,000.00	\$ 23.60	180,000.00	90,000.00	\$ 1,061.82

ANNEX P. KENYA ANNUAL EQUIPMENT COST OF EACH HEALTH FACILITY TO STORE COMMODITIES

Note: Boxes shaded with pale red signify missing data. These costs were estimated using data on similar equipment used elsewhere. Five-year straight-line depreciation was applied to shelves, wheelbarrows, fans, and pallets. When data on maintenance budget were available, 10% of this total was allocated to stock.

Facility Name	Total Equipment (KSh)		Total Equipment (USD)	
	Maintenance	Depreciation	Maintenance	Depreciation
Rangwe Sub District Hospital	-		\$ -	\$ -
Mbita District Hospital	10,000.00	4,000.00	\$ 117.98	\$ 47.19
Port Reitz District Hospital	36,000.00	43,500.00	\$ 424.73	\$ 513.21
Homa Bay District Hospital	-	11,520.00	\$ -	\$ 135.91
Mbagathi District Hospital	60,000.00	17,200.00	\$ 707.88	\$ 202.93
Tudor District Hospital	-	-	\$ -	\$ -
Makongeni Health Centre	-	-	\$ -	\$ -
Miritini CDF Dispensary	-	14,120.00	\$ -	\$ 166.59
Lambwe Health Dispensary	-	-	\$ -	\$ -
Usao Health Centre	3,500.00	3,600.00	\$ 41.29	\$ 42.47
Mlaleo Health Centre	-	-	\$ -	\$ -
Makadara Health Centre	-	-	\$ -	\$ -
Miniambo Dispensary	-	4,200.00	\$ -	\$ 49.55
Bahati Health Centre	-	700.00	\$ -	\$ 8.26
Ngaira Dispensary	8,000.00	560.00	\$ 94.38	\$ 6.61
STC Casino Health Centre	60,000.00	1,560.00	\$ 707.88	\$ 18.40
Maweni Dispensary	-	8,000.00	\$ -	\$ 94.38
Shimo La Tewa Annex Dispensary	1,500.00	1,040.00	\$ 17.70	\$ 12.27
Langata Health Centre	-	600.00	\$ -	\$ 7.08
Tom Mboya Health Centre	-	2,454.55	\$ -	\$ 28.96
Kitare Health Centre	2,000.00	-	\$ 23.60	\$ -
Rariw Dispensary	-	6,000.00	\$ -	\$ 70.79

ANNEX Q. ANNUAL WAREHOUSE COST OF EACH HEALTH FACILITY TO STORE COMMODITIES

Note: To calculate depreciation of a warehouse, a 30-year straight-line depreciation was applied. The year in which the facility was built was collected during interviews. Some facilities provided the initial cost of construction. Boxes shaded with pale red boxes signify missing data. Missing data points were estimated as the median between the three health facilities that provided these data: Mlaleo Health Center, Maweni Dispensary, and Langata Health Center. The research team used two assumptions to focus on specific costs associated with each facility's storage capabilities: (1) 10% of hospital warehouse depreciation costs are allocated to stock and (2) 50% of health center and dispensary warehouse depreciation costs are allocated to stock.

Facility Name	Size - Storage + Dispensary (m ²)	Year Built	Initial Cost (KSh)	Depreciation (KSh)	Depreciation attributed to stock (KSh)	Depreciation attributed to stock (USD)
Rangwe Sub District Hospital	70	1978		-	-	-
Mbita District Hospital	123	1992	750,000.00	25,000.00	2,500.00	29.50
Port Reitz District Hospital	267		20,000,000.00		-	-
Homa Bay District Hospital	300	1960		-	-	-
Mbagathi District Hospital	4000	1960	10,000,000.00		-	-
Tudor District Hospital	36	1970		-	-	-
Makongeni Health Centre	48	2012	3,500,000.00	116,666.67	58,333.33	688.26
Miritini CDF Dispensary	73	2008	3,500,000.00	116,666.67	58,333.33	688.26
Lambwe Health Dispensary	44	2000	3,500,000.00	116,666.67	58,333.33	688.26
Usao Health Centre	56	1990	3,500,000.00	116,666.67	58,333.33	688.26
Mlaleo Health Centre	254	2012	20,000,000.00	666,666.67	333,333.33	3,932.90
Makadara Health Centre	373	1990	3,500,000.00	116,666.67	58,333.33	688.26
Miniambo Dispensary	9	2009	1,000,000.00	33,333.33	16,666.67	196.64
Bahati Health Centre	153	1986	3,500,000.00	116,666.67	58,333.33	688.26
Ngaira Dispensary	73	1966		-	-	-
STC Casino Health Centre	37	1974		-	-	-
Maweni Dispensary	25	2011	6,000,000.00	200,000.00	100,000.00	1,179.87
Shimo La Tewa Annex Dispensary	15	1985	3,500,000.00	116,666.67	58,333.33	688.26
Langata Health Centre	80	1972	500,000.00		-	-
Tom Mboya Health Centre	122	1990	3,500,000.00	116,666.67	58,333.33	688.26
Kitare Health Centre	83			-	-	-
Rariw Dispensary	54	2008	3,500,000.00	116,666.67	58,333.33	688.26